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THE IMPERIAL COLLEGE OF TROPICAL AGRICULTURE, TRINIDAD, B.W.I.

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TROPICAL AGRICULTURE is published at the Imperial College of Tropical Agriculture St Augustine, Trinidad, West Indies, at the end of the third week of the month preceding the one of issue. Advertisement rates can be obtained at the College from the Editor, or from the Secretary of the College, 14, Trinity Square, London, E.C. 3, England. The Editor will be glad to consider authoritative articles for publication. It is understood that opinions expressed in signed articles are those of the author and do not necessarily represent the policy or opinion of the College Authorities. Increasing numbers of inquiries are being received from various parts of the tropics which can be answered only by persons possessed of an intimate knowledge of local conditions. Enquirers should first satisfy themselves that their local Department of Agriculture is not able to supply them with the desired information before communicating with us. Correspondence which will be replied to is invited on all other matters pertaining to tropical agriculture, science and development.

IMPERIAL BUREAUX.

THE system of Imperial Bureaux does not in any way involve new principles, as it has existed for nearly 20 years in the form of such excellent Institutions as, for example, the Imperial Bureaux of Entomology and Mycology. Both these Bureaux have done, and are still doing very good work, but, with the extraordinary rapid progress which has been made within recent years in the development of scientific agricultural research throughout the Empire, it is not surprising to find that the question of the extension of the Bureau system, which is primarily concerned with the collection, collation and dissemination of information of a scientific and technical character, was raised once more at the Imperial Conference of 1926. It was then suggested that further Bureaux might be advantageously established in other sciences, provided that the necessary support would be forthcoming from Empire Governments interested in such a scheme. A similar suggestion came from the Agricultural Research and Administration Committee of the self-governing Colonies who reported in 1927. These suggestions had their effect as much prominence was given to the subject of Imperial Agricultural Bureaux at the Imperial Conference of 1927; the need for certain additional clearing houses for the interchange of information amongst agricultural workers in the Empire was very strongly advocated, and, as a result of recommendations made at this Conference and at a Conference in November last, attended by representatives of the interested Governments, a scheme was drawn up for the establishment and administration of eight new Bureaux which are now attached to existing Research stations. The first three, namely, the Imperial Bureaux of Soil Science, Animal Nutrition and Animal Health which are respectively attached to the Rothamsted Experimental Station, the Rowett Research Institute, Aberdeen, and the Veterinary Research Laboratory, Weybridge, will, for the present, be organised on a larger scale than the other five. These further institutions will deal with animal genetics, agricultural parasitology, plant genetics (crops and herbage plants) and fruit production, and will respectively be located at Edinburgh, St. Albans, Cambridge, Aberystwyth and East Malling. The Governments of the Empire have agreed to contribute £20,000 towards the cost of the Bureaux, and the control and distribution of this fund, and the general supervision and administration of the Bureaux

will rest with an Executive Council appointed by these Governments. The Head of the Research Institute to which the Imperial Bureau is attached will in each case be its *ex-officio* Director. Specialists in the appropriate sciences will also be nominated as official correspondents for each Bureau, by the Governments represented on the Executive Council, and in each country the representative of the Bureau will be the official correspondent to whom the Director of the Bureau may turn for such help as he may require, and from whom he may obtain suggestions regarding the work and activity of the Bureau. It is expected that these correspondents will make it their duty to take a lively interest in the functions of the Bureau and facilitate its activities in the interest of research workers in the Empire as a whole.

The functions of Imperial Agricultural Research Bureaux have been defined as follows: "To act as effective clearing houses for the interchange of information of value to Empire research workers in agricultural science, by maintaining an index of research being carried out in different parts of the Empire and as far as possible in foreign countries; by collecting, abstracting and collating information from all sources bearing on the more important problems investigated, and keeping themselves informed of the general progress of research work within their respective provinces in different parts of the Empire; by summarizing in appropriate cases available statistics which are of importance in connection with their work." Bureaux will be expected to supply information within the scope of their work to officials and advisory officers, such information, to include, if necessary, bibliographies and photo-stat prints of articles on specific problems. As regards the general distribution of information, special monographs may have to be issued from time to time, but it is anticipated that a journal will not be published until the Bureau has become fully established. Although Bureaux will not undertake any laboratory or field experiments, they will be in a position to be of service in various other ways, by giving facilities for the exchange and meeting of workers interested in the same problems in different parts of the Empire, and for the exchange of experimental material for research purposes. Finally, other information of a general character will also be supplied which might be of service to institutions or individual workers.

It will be seen that the programme of work contemplated is a very comprehensive one, and it may be instructive to examine this in the light of the work which has already been carried out by existing Bureaux. The first Bureau was established by the Colonial Office in 1908 for the collection and dissemination of information relating to African Sleeping Sickness. Eventually the scope of this Bureau was widened to embrace all human and domestic animal diseases in the Tropics, and in 1926 with the publication of a new bulletin it became known as the Bureau of Hygiene and Tropical Diseases. Its main function is naturally to collect all possible information on tropical diseases and to distribute it with as little delay as possible to medical and veterinary officers in the Tropics. For this purpose, three serial publications are issued, of which two are concerned chiefly with human diseases and the third with Veterinary Science.

The Bureau of Entomology had its origin in the activities of the Entomological Research Committee which was appointed by the Colonial Office in 1909 to further the study of entomology in tropical Africa. The Bureau which was established in 1913, collects all information bearing upon injurious and useful insects. It has organised a system for the authoritative identification of all insects of economic importance submitted by research workers in the Empire while it also compiles a comprehensive card index of entomological literature. It issues three publications, the *Bulletin of Entomological Research*, which contains original articles on economic entomology, the *Review of Applied Entomology*, which is published in two parts and reviews all current literature on the same subject, and the *Zoological Record* which is a review of the literature of the previous year. The Bureau arranges Imperial Entomological Conferences from time to time, and lately its work has been further extended by the establishment, with the help of a grant from the Empire Marketing Board, of a parasite laboratory for breeding beneficial parasites for export to various parts of the Empire for the control of insect pests.

The Imperial Bureau of Mycology represents one of the younger institutions of the kind as it was established as recently as 1920, following a resolution passed by the Imperial War Conference in 1918. Information is disseminated by means of the *Review of Applied Mycology*, which is a monthly survey of all current literature, dealing with phytopathology and economic mycology from every part of the world. Periodical Imperial Conferences are arranged and the identification and study of fungus and bacterial pathogens has also been undertaken. A museum of tropical plant diseases is maintained and a library for use by overseas mycologists.

To all intents and purposes the Royal Botanical Gardens at Kew and the Imperial Institute fulfil the functions of Bureaux, the first in the domain of Botany and the second as an investigator of Empire raw materials. These two institutions which are too well known to need further descriptions have both carried out exceptionally valuable work in their own spheres of activity.

It will be realised no doubt that Bureaux have been primarily designed to supply information to research workers and that the responsibility, therefore, of spreading new information will essentially remain in the hands of the latter. In other words, the Bureau as a central organisation will act as an Intelligence Service which will supply its information to the research officials of the local teaching Institutions or Agricultural

Departments. This information will then be passed on to the local research investigator who will in turn disseminate it amongst the planting community. In the event of information being required the process will merely be reversed.

The new Bureaux will naturally have to organise their work on their own lines as the problems to be confronted will vary according to the subjects dealt with. The primary needs, however, of a research officer, will have to be kept well in mind. The existence of the new Bureaux will be amply justified if they can keep him up to date with, preferably, as much original literature as possible on the subject studied, together with translations of the more important works, the crying need at present of numerous investigators; if they can help him to identify and, if necessary, to collect specimens from all parts of the world, and, in short, if they can keep him in touch with the whole realm of his pursuits. The research worker could help, in turn, by supplying the Bureau with a concise account of his own activities, and of any new observations he may have been making. The result of such co-operation has, in the past, been invaluable, and it can only be hoped that such co-operation will continue to exist with the formation of our eight new Imperial Agricultural Bureaux, whose future development will be watched with great interest.

THE INSTITUT COLONIAL.

The *Institut Colonial International* which held its twentieth session in Brussels in June last, under the presidency of the Crown Prince Leopold of Belgium, was founded in 1894 for the scientific study and discussion of colonial problems. The Institute is composed of a limited number of members chosen from among the citizens of states possessing colonies who are distinguished in colonial policy either by reason of their colonial experience or by their studies and writings upon colonial matters. The Institute promotes and extends the comparative study of administration and colonial legislation, international relations between those who are occupied with the study of law and legislation concerning colonies and the exchange of ideas and data in all matters relative to colonization.

The centre of administration of the Institute is in Brussels, but its meetings take place, usually every two years, in different capitals. The two previous meetings were held in Rome and the Hague, and the next meeting in 1931 is to assemble in Paris. France, Holland, Italy, Spain, Portugal and the British Empire were represented at this year's meeting.

The greater part of the work of the Institute is done by the preparation in the intervals between the sessions of elaborate reports upon important topics that are to be discussed. These reports are published and circulated to members and subscribers, and while they afford unique summaries of the subjects with which they deal they also permit the discussions at the sessions to be concentrated upon essential points. The topics under consideration in the interval between the nineteenth meeting at the Hague (1927) and the twentieth at Brussels (1929) have been three:—(1) The Organization of Native Labour in Tropical Colonies, the report being prepared by M. Schumann, late President of the Volksraad of the Netherland Indies; (2) The Organized and Intensive Furtherance of Indigenous Cultures in Tropical Colonies, upon the report of M. de Wildemann, Director of the State Botanical Garden, Ghent; and (3) Representative Assemblies in African Possessions, upon the report of M. Fidel, of the *Union Coloniale Française*.—(*United Empire*, Vol. XX, No. 8.)

BUD MUTATION IN COTTON.

A form of *Gossypium arboreum* (Linn.) known as Burma Laciniated, with extremely deeply laciniated leaves has been grown for several generations at the Cotton Research Station. The original plant appeared in a mixed lot of Asiatic cottons grown from seed brought by Dr. S. C. Harland from Mahlaing, Burma. A graft from a plant of the second generation grown in Trinidad was planted in the greenhouse. Selfed seed from this graft was planted, and bred true in all obvious characters.

In June, 1929, the grafted plant gave rise to a branch which has broad leaves. The leaf index (length of leaf ÷ length to sinus) of typical leaves is about 10 to 13. The leaf index of leaves on the mutant branch is about 2.0 to 2.2. The photograph on page xii, shows the mutant branch and normal branches bearing laciniated leaves.

This mutation has crossed at one step the boundary between *G. arboreum* and *G. nanking* (*See* Watt [1]), which Leake [2] has shown is due to a difference in a single gene. Since the arboreum (laciniated) type of leaf is dominant to the nanking type in Trinidad, and since Burma Laciniated has been shown to breed true, it follows that the same mutation occurred in both homologous chromosomes. It would be of great interest to discover whether the two mutations occurred simultaneously or whether one followed the other. The first two leaves on the mutant branch (indicated by arrows in the plate) are laciniated. The branch was cut off above the third leaf, and grafted on to a perennial stock. A shoot appeared at each of the three nodes, and an extra shoot appeared from a bud on the parent branch at the base of the mutant branch. This latter bore laciniated leaves. The shoots from all three nodes on the mutant branch had broad leaves. Clearly both mutations occurred below the first node on the mutant branch, and were either simultaneous, or followed one another during the formation of a single node which is only 2 mm. long.

J. B. H.

1. Watt, Sir G.—The Wild and Cultivated Cotton Plants of the World. *Longmans Green & Co.*, 1907.
2. Leake, H. M.—Studies in Indian Cotton. *Jour. Gen.*, Vol. I, No. 3, 1911.

WHITE GRUBS.

The White Grubs of North Queensland Cane Fields.

BY E. JARVIS,

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Introductory.

MOST farmers are aware that the term "White Grub" is merely a popular name given to the larvae of a large section of Scarabaeid or Lamellicorn beetles; referring principally, however, to cockchafer grubs of the so-called "May Beetles" or "June-Bugs"; of which the genera *Lachnosterna* and *Melolontha* in America and Europe, respectively, afford typical examples. In the canefields of Queensland the destructive melolonthids belong to the genera *Lepidoderma* and *Lepidiota* which, together with two others, represent collectively five species of decided economic importance.

In the present article it is proposed with the help of diagrams to describe very briefly these cockchafers and also to illustrate the specific differences by which it is possible to identify easily the larval form of each of the Queensland cane-beetles.

The control methods advocated here are those which, in the course of laboratory and field work carried out at Meringa Sugar Experiment Station during recent years, have been found most effective against such cane pests.

The "Grey-Back" Cockchafer.

The notorious "Grey-Back" Cockchafer, *Lepidoderma albohirtum* Waterh—is the largest and the worst insect cane pest of North Queensland. This beetle which measures 34 mm. (nearly 1⅜ inches) by 18 mm. wide—usually emerges from the ground during November or December, a few hours after the occurrence of thunder showers heavy enough to penetrate to the depth of the pupal chambers, thus enabling it to reach the surface. This insect is deep reddish-black, but owing to the dense scaly covering of its elytra or wing-cases appears to be of a general greyish-white colour. (Fig. 2.) The antennal club of the female consists of four plates or lamellae, and that of the male of five. Favourite food-plants are species of *Ficus* (native figs), and *Eucalyptus*; the aerial existence of this beetle varies from 14 to 18 days.

The Egg.—The female oviposits about a couple of weeks after leaving the ground in a roughly made cavity or egg chamber, which is generally situated just under a stool of cane, and may contain from 15 to 30 eggs. These are obtusely ovate, pale whitish-yellow, with the chorion or shell of a leathery texture.

The Grub is creamy or bluish-white in colour, measuring about 35 mm. (1⅜ inches) in doubled up position (*see* Fig. 1). The ventral surface of the anal segment has two parallal rows of short bristles surrounded by longer hairs arranged in the manner shown in Fig. 4.

The Pupa.—Pupation usually takes place in September or October under a row of cane stools in a chamber fashioned by the grub at a depth of from 12 to 18 inches, the sides of which are carefully puddled in order to exclude ants or other small enemies, or prevent injury from flood rains.

Nature of Injury.—Damage to the crop is due to gradual destruction of the main roots near the surface, coupled with subsequent injury to the cane-sticks by third-stage grubs which gnaw large holes in the underground basal portions. Wilting of the leaves is often the first indication of the presence of this insidious foe, and in cases of severe attack is quickly followed by yellowing and final death of the entire plant.

As this very destructive insect has only a life-cycle of one year, of which about six months are passed in the grub condition, its ravages at times, cause considerable alarm amongst cane growers. (*See* Fig. 3.)

Methods of Destroying "White Grubs."

For the last 40 years or more incessant war has been waged against the larvae of cockchafer beetles, the control of which is considered to be one of the most acute problems facing economic entomologists.

The methods of repression followed, naturally vary somewhat in each country, because they are directed against different species of melolonthinae of varying economic importance and with varying life-cycles.

Experience in North Queensland has shown that fumigation of grub-infested soil offers the best chance of ultimate control of the "grey-back" cockchafer.

The Paradichlorobenzene Treatment.

The most effective soil fumigant for this purpose is paradichlorobenzene, in the form of dry crystalline nodules, applied in ⅛ to ¼ ounce doses placed 15 to 18 inches apart along each side of the cane rows, about five inches from the plants and 4½ inches deep. Before this is applied the nodules should be passed through a ¼ inch mesh sieve.

Applied thus the cost of treating an acre of cane, even at the price of 10*d*. per lb., works out at about £4 10*s*. 0*d*. The simplest and most economical method of application is to mix the fumigant with the manure when giving a final dressing to cane from three to five feet high. Any form of fertilising machine can be used,

WHITE GRUBS.

FIG. 1—*Grub of "Grey Back."*

FIG. 2—*"Grey Back" Cane Beetle.*

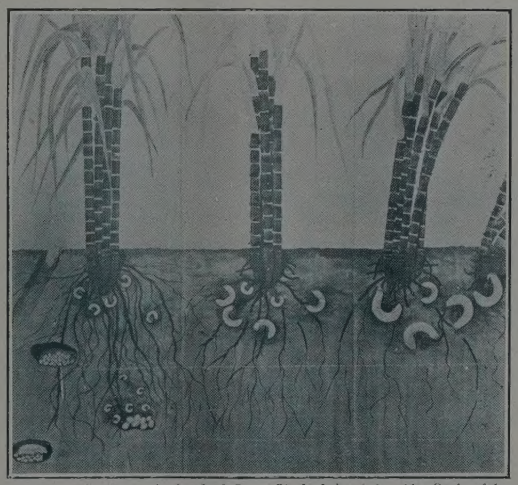

FIG. 3—*Diagrammatic sketch of Cane Stools being injured by Grubs of the grey-back cockchafer during the months of January to March.*

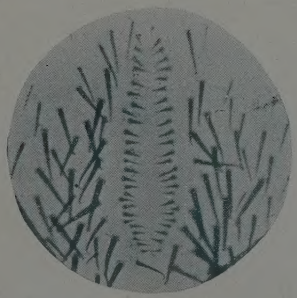

FIG. 4—*Arrangement of bristles of anal segment of grub of 'L. albohirtum Waterh.'*

FIG. 5—*"Asilid Fly"—predaceous on various winged insects. (Nat. size.)*

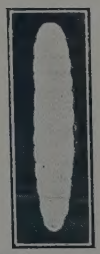

FIG. 5a—*Larva of "Asilid Fly" predaceous on cane grubs in the soil. (Nat. size.)*

WHITE GRUBS.

FIG. 6—*Larva of 'Agrypnus mastersi Pascoe' predaceous on subterranean grubs.* (*Nat. size.*)

FIG. 6a—*Adult beetle of 'Agrypnus mastersi Pascoe.'* (*Nat. size.*)

FIG. 7—*Maggot of "Digger-wasp." Parasite on maggots of several species of cane grubs.* (*Nat. size.*)

FIG. 7a—*"Digger-wasp."*

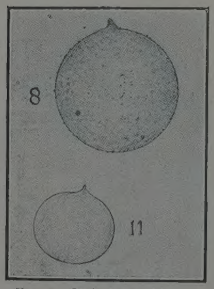

FIG 8—*Scale from wing case of 'L. frenchi'*
FIG 11—*Scale from wing case of 'L. caudata.'* (200 *times Nat. size.*)

FIG. 9—*"French's Cane Beetle"* (*Nat. size.*)

providing it will bury the mixture about four inches deep, return the soil to the drill, and consolidate the disturbed surface by slightly rolling it to a uniform level.

The advantage possessed by this fumigant over all others lies in its slow evaporation, since the volatile fumes given off from one-eighth of an ounce continue operative in the soil for a period of three weeks or longer. Being about five times heavier than air the toxic vapour permeates downwards throughout the depth of cultivation, and even into the undisturbed sub-soil of volcanic lands.

Paradichlorobenzene is harmless to human beings and domestic animals, non--poisonous, clean to handle, non-inflammable, and practically insoluble in water.

This chemical, can be applied by means of Hand Injectors; or by Corn or Seed Planters, designed so as to drop and bury uniform doses at regular distances apart. On no account should paradichlorobenzene be dissolved in carbon bisulphide or other media, with view to injecting it in a liquid form; as when treated in this manner, its most desirable quality, viz.:—its long sustained toxic action, is practically destroyed; to say nothing of the needless cost incurred for labour and additional material.

Collecting Cane-Grubs.

Where cheap labour is available the practice of picking up grubs from behind the plough on badly infested areas, should not be neglected. Those engaged in such work ought to learn to distinguish between the appearance of grubs of scarabaeid beetles and those of soil-frequenting larvae of beneficial insects occurring in the same furrows, but which are parasitic or predacious on cane-grubs.—(*See* Figs. 5, 5a, 6, 6a.)

French's Cane-Beetle.

"French's Cane-Beetle" (*Lepidiota frenchi* Blkb.) ranks about second in destructiveness in canefields of North Queensland. Were it not for the fact that it has a two-years life-cycle, this insect would doubtless prove a very serious cane pest.

The Beetle is dark reddish-brown, slightly clouded with a whitish tinge, due to the elytra being closely punctulate, with each puncture covered by a tiny, white, nearly circular, flattened scale (Fig. 8). Sides of pronotum acute, with the edge dark red, turned upwards, and symmetrically scalloped. The ventral or lower body surfaces are more or less thickly clothed with white scales, which are circular on the central area of abdominal segments, but absent near anterior edges of same; minute on sides of body, round to pear-shape on thoracic plates, and replaced by long silver hairs near the coxae. The length of this beetle is 24 mm. (nearly one inch) (Fig. 9).

The eggs are deposited separately, each being isolated in a small cavity measuring about 5 mm. in diameter, with compacted sides; the entire batch (varying from 26 to 39) occupy a space of not more than a couple of cubic inches of soil. The shell is tough and silvery-white, almost spherical, and with the surface granulate. The marriage flight commences upon the first indication of twilight, when, without warning of any kind, myriads of these beetles start up simultaneously from every quarter, dashing wildly to and fro as if determined to exercise their wings to the utmost. Standing amongst the cane stools one becomes encompassed by an immense swarm of beetles, thousands being in view at the one time—which in their erratic and ill directed flight are constantly striking sharply against the stiff cane leaves. After this tumultuous marriage flight, lasting about ten minutes the beetles are seen on all sides clinging in couples to cane leaves, bushes, or wire-fences, &c., at a height of about four feet from the ground.

The Grub of this species is nearly as large as that of the "grey-back" cockchafer, from which, however, it may be easily distinguished by the different arrangement of bristles on the anal segment, as shown in Fig. 10. The period passed in the larval condition (from hatching of the eggs to pupation of the grub) is about 18 months.

Nature of Damage.—This happens every second year, during the months of September to December, when the grubs are in the third instar or fully grown, and is very similar in character to that caused by the preceding cane-beetle. Young shoots of ratoon and plant canes are chiefly attacked, such infestation, however, being mostly in patches varying in size from one square chain to half an acre or more.

Early indications of injury are first noticed during September and October, when affected shoots assume a yellowish tinge, which in cases of severe attack may be followed by death and browning of the heart-leaves. No time should then be lost before fumigating such grubby areas with carbon bisulphide which is generally applied by means of a Hand Injector designed for using liquid fumigants, such as the "Vermorel Pal Excelsior" or "Danks Injector" (*See Queensland Agricultural Journal*, Vol. XXIX, pp. 107-112, Feb. 1928).

The "Glossy Scrub Chafer."

Lepidiota caudata Blkb. is a dark purplish or brownish-red beetle, a little larger and of deeper colour than the preceding species. It occurs principally close to scrub land and being at times abundant and harmful over cane lands bordering the Mulgrave river near Babinda and Bellenden Ker is deserving of special mention. This is one of the first cockchafers to emerge, making its appearance during September.

The Beetle differs from *L. frenchi* in having the dorsal surface of the elytra more sparingly and minutely punctulate, in having the scales on its wing-cases much smaller (Fig. 11), the central area of the abdominal ventral surface, blackish and almost bare with scales ovate and pear-shaped instead of circular, and the third tooth at middle of front tibiae being blunter and smaller than in *frenchi*. Length of body about 1 inch (25 mm.), (Fig. 12).

The grub, which is often mistaken for that of *frenchi*, may be distinguished at once by the arrangement of the anal bristles. The central patch of hairs in both species is more or less top-shaped, but in the latter the central path is naked and well defined, (Fig. 10), while in *caudata* the bristles usually meet from each side, so as to cover the path. (*See* Fig. 13.)

The *Nature of Damage*, and *Control Methods* are similar to those described in connection with *albohirtum* and *frenchi*.

Dynastid Beetle or "Red-Head."

The frequent occurrence of this abundant species *Dasygnathus australis-dejeani* Macl. in cane-fields, coupled with its very extensive range of distribution, entitles it to rank as a cane-beetle of some importance. *The beetle* varies in colour from uniform dark shining brown to black. The elytra are striated, each wing-case having about seven rows of coarse punctures. The pronotum, although appearing smooth, is in reality minutely punctulate, of simple form in the female, but with front vertically hollowed in the opposite sex and produced into two short obtuse points. The head of the male is also provided with a short slightly curved horn. Length of beetle about three-quarters of an inch (19 mm.). (Fig. 14.)

The Egg is white, elongate ovate, with ends less obtuse than in those of *frenchi*, each being deposited in a cavity made in a nodule of consolidated soil.

The Grub of this beetle eats into and devours the basal underground portion of the succulent young shoots of growing cane setts. Its head is of a darker reddish-brown than that of grubs of genus *Lepidiota*; hence the term "red-head" often applied to them by cane growers.

Unlike grubs of the genus *Lepidiota* the larva of this species is able, by flattening itself on the ventral surface to crawl slowly over level ground.

The "Christmas" or "Golden Beetle."

In the Herbert River district this beautiful beetle *Anoplognathus boisduvali* Boisd. is responsible at times for damage of a more or less serious nature. In the Cairns and Babinda areas, however, it seldom causes trouble unless found in association with grubs of other scarabaeids infesting cane-land in the near vicinity of low-lying ground supporting trees of the "Broad-leaved Gum" (*Eucalyptus platyphylla*), which is one of its favourite food-plants.

The Beetle is lustrous creamy-grey with faint green and pink iridescence, the lower body surface being iridescent coppery-green. Its head, pronotum, and scutellum are metallic greenish-gold, while the tibiae and tarsi are purple. The length of this insect is about one inch (25 mm.), as shown in Fig. 16.

The Eggs, which vary in number from 34 to 63 or more, are usually found in moist soil at varying depths, each egg being isolated in a tiny cavity made in the centre of a hard nodule of earth, just large enough to allow for expansion of the embryo during development.

The Grub when fully grown is about the same size as that of *frenchi*, from which it differs in having a darker yellow head of less width, while the vestiture or hairs on the last body or anal segment are long and reddish, arranged as shown in Fig. 15. Like the grub of the preceding insect, the larva of *Anopolgnathus boisduvali* Boisd. is able, by lying flat on its lower body surface and extending its legs on each side to crawl rather briskly over level ground.

The control methods for this and the preceding cane-beetle are very similar to those described for the "grey-back cockchafer." Both *D. australis-dejeani* Macl. and *A. boisduvali* Boisd. subsist mainly on decaying vegetable matter, rather than on the living tissue of cane roots, and have a one-year life-cycle.

DENICOTINISED TOBACCO.

An account of the so-called 'denicotinised' tobacco is given by E. M. Bailey and others in the Report of the Connecticut Agricultural Experiment Station for 1927 (*Bulletin* 295). Many of these tobaccos are now on the market bearing the advertisement that the bulk of their nicotine has been removed, from which the consumer naturally concludes that the product has been rendered harmless. Actual analyses, however, revealed the fact that on an average only one-half to one-third of the nicotine is removed in the re-sweating process. Further, since the percentage of nicotine varies enormously in different tobaccos, it is possible for a 'denicotinised' product to show as high a nicotine content as some other untreated tobaccos. For example, the lowest percentage of nicotine found in a treated tobacco was 0.75, but certain types of Havana, Porto Rican, and Turkish tobaccos normally contain as little as one per cent. From this it is clear that unrestricted indulgence of these tobaccos by people who suffer ill effects from nicotine is unwarranted. The authors conclude with the suggestion that methods mav be found which entirely remove the nicotine, though they raise the obvious query whether such refined tobacco would retain the qualities for which smoking is enjoyed.—(*Nature* No. 3110, Vol. 123.)

FRUIT AND VEGETABLE STORAGE.

BY DR. LAURENCE P. MCGUIRE,

Physiologist, Banana Research Station, Imperial College of Tropical Agriculture.

[*In response to a number of inquiries regarding the optimum storage and transport temperatures for fruit and vegetables, which are either indigenous to, or may be cultivated in the Tropics, the following summary of current relevant literature is published below.*]

Introduction.

GENERALISATIONS regarding the optimum conditions for the cold storage of food products, are, to say the least, difficult even for fruits or vegetables of a single genus. So much depends on the particular species or variety, the pre-storage conditions of nutrition (soil and climate), the stage of ripeness attained at the time of harvesting, the duration of the particular storage-temperature, the amount of ventilation, the composition of storage atmosphere—humidity and concentration of carbon dioxide and volatile auto-toxins.

It must be borne in mind that up to the present, experimental storage trials with vegetables have, for the most part, been confined to those grown in the temperate zones. In the case of vegetables cultivated in the tropics, it will be by experiment, and experiment alone, that consistent successful transport from season to season, may be expected. The present paper, culled from current literature, is submitted in the hope that it will provide prospective shippers with the rudimentary knowledge, with which experimental shipment may be commenced. Experience gained in the course of smaller preliminary trials will later justify large-scale operations.

It will be seen that investigators in different parts of the world recommend different optimum temperatures for the same fruit; in the absence of definite knowledge as to the variety, which is frequently not specified, this information appears at first sight to perplex, rather than assist. The references are given, so that in the event of unsatisfactory transport at one temperature, the other temperatures may be resorted to in turn.

Lastly, many fruits may be held successfully over comparatively long periods at ordinary temperatures; as a general rule, the average storage expectancy of these fruits may be increased by storage at lower temperatures. Refrigeration is recommended during transport firstly to reduce, to a minimum, wastage due to the activities of putrefactive organisms and fungal growth generally and secondly to allow, if necessary, of further storage at the port of destination in the event of a glut of the same commodity, from a different country of origin (cf. citrus on the English market from South Africa, Palestine, Azores, Canary Islands, &c.). The advantage under such circumstances, of being able to delay senescence for a further period, will be readily conceded. A careful study of Trade-Commissioners' reports, based on first-hand information as to the trend of the market, would be helpful in this connection.

A. Vegetables.

By way of introducing this aspect of the subject, reference will be made to the work at Norrköping, Sweden, of Lorenz Rasmusson ([33]), who carried out storage trials on a number of Swedish vegetables; after this, individual vegetables will be dealt with. He claims that in the case of *Swedish Cauliflowers, Leeks, Red Cabbages, Brussel Sprouts, Artichokes, Jerusalem Artichokes, Beet-roots, Horse-radish, Celery, Parsnips, Cabbages, Carrots, Sweet Marjoram, Thyme, Parsley, Dill* and *Turnip-cabbages*, he has increased the length of storage life to an extent varying from four to nine months, and in the case of *Salad, Spinach* and *Tomatoes*, to two months. Krause ([22]) observes further that (1) Cauliflowers should be stored perfectly dry, otherwise they soon assume a greyish-white appearance and become covered with black sooty spots, which diminish their value considerably; (2) Artichokes, Celery, Parsnips, Beetroot and Horse-radish, kept best in dry sand* and in premises without light; (3) Marjolaine, Thyme, Fennel and Parsley, are inclined to lose their flavour in open crates. Zinc cans were found highly suitable.

All these vegetables were kept at a storage temperature of 32° to 33.5° F., and humidity 70 to 80 per cent. Generally speaking, vegetables should be packed in latticed crates in such a way as to ensure adequate ventilation, vitiated air being removed by periodically opening the storage doors for a short while.

Tomatoes.

This commodity presents difficulties in storage, and advice as to the optima conditions of such storage must, of necessity, be guarded, owing to the considerable variation in keeping quality.

Rasmusson ([33]) (Norrköping) kept tomatoes for two months at 32° F.; Plank ([31] and [23]) of Karlsruhe kept them for 34 days at the same temperature, remarking that on the fourth day after removal from storage, deterioration due to mould formation was considerable.

According to D. B. Adam ([1]), with tomatoes picked when three-quarters ripe and stored at 33° to 34° F. in ventilated chambers where humidity is relatively low, the average storage expectancy of 7 to 10 days, may be lengthened to three weeks.

On the other hand, Barker ([3]), of the Low Temperature Station, Cambridge, experimenting with both green and fully-coloured tomatoes, is of opinion that the extension of the ripening and senescence of the tomato to any considerable

* For the purposes of transport, dry packing material would be substituted for sand.

extent by cold storage, is not feasible. The experiments, which are by no means complete, suggest that the optimum storage temperature lies in the neighbourhood of 55° to 60° F. Storage at 34° F. might be recommended for the preservation of tomatoes as provisions for ships, where consumption would take place shortly after removal from storage.

H. C. Diehl [11] reports that experiments conducted with small lots of Acme, Globe, and Stone varieties, gave results which indicated that such tomatoes were not injured when held for one day at 30° to 31° F. When subsequently stored at 50° F. for nine days, they ripened very gradually, and if then held at room temperatures of about 70° F., they matured normally in five to seven days—a storage life of about 15 days. [Tomatoes of the same stage of development, held at 32° F. for periods varying from 14 to 30 days, failed to ripen, and quickly broke down at room temperatures.] If this procedure is adopted in transport, the preliminary cooling at 31° F. should be carried out in the Harbour pre-cooling station, after which the crates should be quickly conveyed to the boat chamber kept at a temperature of 50° F.

In harvesting tomatoes, a small portion of the stem should be left on the fruit, and furthermore, the use of individual wrappers for the fruit, which have been shown to retard the ripening process perceptibly should be encouraged.

It should be clear from the foregoing that, different varieties require different sets of conditions, which will be determined in the course of experiment only.

Onions and Garlic.

Experimental work at Norrköping [34] (Sweden), shows that at temperatures of about 30.5° F., onion tissue is altered by putrefaction, mould, and germination. On the other hand, very low temperatures, 19.5° to 23° F., kills the tissue and coagulates the albumen, which after thawing, remains de-natured. At 27° F., the tissue remains unaltered, and on removal to higher temperatures, is similar to that of fresh onion, chemical analyses supporting the view. Cultivated *Garlic* may be kept at 21° F. without danger; nevertheless, 27° F. is quite adequate for satisfactory preservation. V. R. Boswell [5] studied the behaviour of onions during, and subsequent to, storage at 32°, 40° and 50° F., and found the lowest temperature most suitable. Furthermore, onion plants from the bulbs stored for eight months at 32° F. showed extraordinarily vigorous leaf growth.

For the purposes of a short voyage of 14 days, *Onions, Garlic, Leeks*, and possibly other members of the same family, *viz.: Spring-Onions* and *Eschalots*, could be safely carried at 32° F.

Potatoes.

Keeping potatoes at a temperature of 32° F. for long periods (four months), helps sugar aggregation, since at this temperature, respiration is slower than saccharification. Even at 36.5° F., sugar aggregation is noticeable in the slightly sweetened taste if the potato has been kept for any length of time at that temperature. From this point of view, storage at 37° to 41° F. is advisable [40].

Stuart *et al.* [37] observe that the range for complete dormancy of bulk-stored potatoes is between 36°F. and 40°F., and for normal potato storage a room temperature of 37°F. is apparently sufficiently low to prevent germination, at the same time insuring as low a transpiration and respiration loss as is desirable.

Storage of potatoes (1) at 35° to 37°F. eliminates storage rots [18] among seed potatoes, and (2) at 36° to 40°F., for 15 days kills the caterpillars, pupae, and eggs of the potato-moth (*Phthorimoea opercullela* Zell.). It is further to be noted that the germinating power of seed potatoes kept at cold temperatures for as long as six months, is not impaired at all, such seeds giving rise to a more uniform crop of sturdier plants. This view is supported by Etheridge [12] and co-workers of the Missouri Station.

As a result of his study of the relation between the storage-temperature and the incidence and spread of storage dry-rot, Morris [27] advises holding potatoes in well-ventilated rooms maintained at 35° to 40° F.

Kimbrough [21], having measured the initial rate of respiration when potatoes are removed from storage at different temperatures, found 40° F. to be the most suitable.

The concensus of opinion, then, favours storing potatoes at approximately 40° F.

Sweet Potatoes.

J. I. Lauritzen [24], working on the temperature and humidity relation of black rot in sweet potatoes in storage, claims that at temperatures of 43° to 50° F. and humidity below 90 per cent., it is believed possible to eliminate, almost entirely, the incidence and spread of this disease. Thompson [33] reports that when sweet potatoes are thoroughly dried or cured, the temperature for long storage should be maintained at as near 55° F. as possible, Crider and Albert [7] advancing a similar recommendation. Sweet potatoes, then, should carry favourably at 50° to 55° F.

Carrots.

Carrots were kept 22 weeks at 32° to 35° F. and 39° to 40° F., losing 7 per cent. and 26 per cent. of their weight respectively. Hasselbring [15] observes that the hydrolysis of sucrose into reducing sugars was more rapid at the higher temperature. As the flavour is correlated with the sucrose content the lower temperature is recommended, *viz.:* 32° to 35° F. Lauritzen [25] has shown that at such temperatures infection and decay, due to black rot disease, are reduced to a minimum.

Celery.

Care should be taken to pack in dry material ([22]) and to ensure ample ventilation. A temperature of 31.5° to 32° F. has been found most suitable ([42]).

Asparagus.

Plank's ([31]) investigations at the Institute of Refrigeration, Karlsruhe, indicate that asparagus in baskets may be kept approximately three to four weeks at a temperature of 32° to 35.5° F. and humidity 80 per cent. Bisson, Jones and Robbins ([4]) recommend that asparagus should be stored as quickly as possible after harvesting in chambers at slightly above 32° F.

French Beans.

Scarlet runner beans ([23]) were held with favourable results in loose heaps for three weeks at a temperature of 32° to 38° F. and humidity 85 per cent. They lost 20 per cent. of their weight in this period of storage.

Parsnips.

Boswell ([6]), studying the parsnip from the point of view of changes in quality and chemical composition during storage, found that roots may be rapidly brought to a state of high table quality by storage at 32° to 34° F., the hydrolysis of starch and other polysaccharides, with consequent accumulation of sucrose, proceeding much more rapidly than at ordinary temperatures. The commercial value of this product is enhanced by holding at a temperature of 32° to 34° F. for three weeks.

Squashes.

Squashes may be conveniently kept for long periods at 50° to 55° F.; at temperatures higher than this, squashes undergo a great loss of weight. Cummings and Jenkins ([8]) point out that squashes kept at 74° F. lost 63 per cent. of their weight in five months, while a comparable lot held at 55° F. for the same period, lost only 20.1 per cent. In a storage test of squashes and pumpkins, the mammoth cheese pumpkin kept in good condition for 17 months. A storage temperature of 50° to 55° F. seems adequate.

Topepos.

Topepos have been kept unrefrigerated, and only towards the end of a period of 18 days, was a slight inclination to shrivelling noticeable. On maturing, the orange colour turned to deep red. Experimental transport might be commenced at temperatures in the neighbourhood of 50° F.

B. Fruits.

Citrus Fruits.

Citrus fruits, generally speaking, should present no difficulty to the shipper in the matter of a fourteen-day journey. Ocean transportation studies indicate that if pre-cooled to 50° F., citrus fruits may be shipped from Porto Rico ([26]) to New York in the ventilated holds of non-refrigerated ships, the temperature not rising much above 60° F. Citrus fruits (Grapefruit, Oranges, Tangerines, Mandarins, &c.), are exported from South Africa at 38° to 40° F.

Grape Fruit.

Hawkins and Barger ([16]) have shown that cold storage of grape fruit is commercially practicable. Records show that for fruit to be held for six weeks in storage, pre-curing by exposure to from 70° to 75° F. at a humidity of 65 per cent., or by exposure to the gases generated in the incomplete combustion of kerosene stoves, reduced skin-pitting injury. The latter treatment is superior, in being beneficial also in the loosening of the stem buttons, the absence of which tended to reduce disease infection in the fruit. These authors further point out that fruit picked early in the season can be readily stored for six weeks to two months at 32° F.

Oranges.

The investigations of D. B. Adam ([2]) with Washington Navel and Valencia oranges, indicated that 34° F. is the most favourable storage temperature, taking into consideration both keeping quality and freedom from spotting. G. B. Tindale ([39]) considers 37° F. to be the most suitable temperature for Valencia late oranges, as a fluctuation of three degrees either way would not be attended with harmful results.

Lemons.

As a result of curing and storage tests of lemons at Gosford, W. B. Stokes ([36]) concludes that lemons harvested green may be held successfully in a well-protected store-room for several months at a temperatute of 70° F. or below, and relative humidity 80 to 85 per cent. Read ([35]) further supports the view that with careful handling, picking, curing, &c., lemons may be kept in ordinary cool storage for six months in excellent condition. For the purposes of short transport, then, refrigeration in the ordinary sense, seems unnecessary.

Limes.

When picked fully grown but still quite green, limes last comparatively well in ordinary cool storage—shipments of this fruit from Trinidad at temperatures in the neighbourhood of 45° F. have on arrival at the market been favourably commented upon.

At temperatures of approximately 38° to 40° F.—the South African practice—or more widely, 35° to 45° F., the transport of citrus fruits should prove successful.

Mangoes.

Higgins & Punzalan ([19]), from experimental storage of varieties of mangoes at temperatures of 36°, 40°, and 50° F. state that sound, green, but fully matured mangoes, may be kept in satisfactory condition for 18 to 35 days at 36° F.; at 40° F. fungus injury was prevalent and at 50° F. shrivelling and decay soon occurred.

Pineapples.

While individual cases of pineapples, sent home in the ship's provision room, have reached their destination in good condition, this is by no means the rule. Experience has shown clearly that pineapples cannot endure low temperatures, on removal from which they rapidly break down—a view supported by Davies (9). Studies at the Porto Rico Station (26) show that exposure to 35° to 40° F. will stop maturity changes considerably, whether fruits are green or mature—storage at this temperature for six days did not interfere with proper ripening, subsequent to removal from the store. Transport at 43° to 45° F., with adequate ventilation, is recommended.

Grapes.

Malaga (South African) grapes, harvested in late March and early April and packed in boxes with sulphite tissue paper and wood-wool, were kept at 32° to 33° F. for five months in excellent condition. De Castella (10) further confirms the view that 33° F. is the most suitable temperature for the transport of grapes.

Melons and Cantaloups.

Urbina (41), in an article on the transport of melons from Chili, is of the opinion that 32° to 34° F. is the best temperature for the preservation of melons in excellent condition. He stresses the importance of (1) careful handling to obviate mechanical injury, and (2) adequate ventilation, and recommends that the storage compartments be loaded to two-thirds of their height. With suitable "dunnage" between crates and adequate circulation of the air, this precaution may reasonably be omitted. For short journeys, Californian cantaloups are carried at 40° F.

Pomegranates.

On account of the texture of the skin, this fruit will withstand a deal of abuse. After harvesting, the fruits, which should be clipped rather than pulled, will keep for months if stored in a cool, dry place. Although the bright lustre of the fruit is lost and the fruit shrivels somewhat, the flavour is not impaired in any way. Hodgson (20) further observes: "on account of the common habit of splitting, the fruit of most varieties must be picked before fully mature. Fortunately, the pomegranate is one of those fruits which, after reaching a degree of maturity, continues to ripen in cold storage, where it will keep in excellent condition for five to six months. Not only does it ripen, but the quality is improved, the flavour becoming richer and more vinous."

This commodity, then, should present no difficulty to the shipper.

Paw-Paws.

Careful packing is absolutely essential in the transport of paw-paws. J. E. Higgins (18), of the Hawaii Experimental Station, reports: "The use of crimped straw board as an exterior wrapper to go about each fruit, in addition to the paper wrapper (glazed) is recommended. This provides a very valuable elastic cushion, against which the fruit rests, and which saves the fruit much bruising . . . Refrigeration can be recommended for the shipping of papaias. No deterioration in the flavour of the fruit could be detected after it had been in refrigeration throughout the voyage to San Francisco, nor were there any other evil effects apparent."

An experimental shipment at 38° to 40° F. of a few cases from South Africa to the London Market (about 24 days altogether in transit) suggests that the West Indian paw-paws, in view of their proximity to the market, might be exported with success at this temperature.

Avocado Pears.

Overholser (29) reports as follows: "40° F. proved to be satisfactory for all varieties tested, except the Fuerte, which required 45° F. to prevent blackening of the skin. It was found that quick storage after harvesting, and care in handling, aided in keeping the fruits in satisfactory condition. Fruits picked just before the commencement of softening, kept best and attained excellent quality. In proper storage, the Dickinson, Royal, Taft and Queen varieties kept for approximately two months; Spinks, Sharpless and Challenge, five to six weeks, Rey Fuerte and Kist, for about four weeks." Several varieties (28) gave indication that they might be kept without injury at a temperature of 32° to 35.6° F.

Litchis.

At the Hawaii Experiment Station (17), it was found that "Refrigeration, where it is available, furnishes the best means of preserving the litchi for a limited period in its natural state." Unfortunately, no actual temperatures are given but it is to be remembered that the fresh fruits keep quite well at ordinary temperature for two to three weeks without deteriorating in flavour, although the attractive red colour of the fruit is lost. Refrigerated fruit, on the other hand, showed no loss in colour or flavour during storage for a fortnight. Experimental shipment might be commenced with temperatures in the neighbourhood of 40° to 45° F.

Jujubes. (*Zizyphus spp.*)

According to Popenoe (32), no weather appears too hot for its cultivation, and it has withstood, without perceptible injury, a temperature as low as 13° F. In storage trials conducted by Overholser (30), jujubes have been kept at 32° F. in open containers for 45 days, and remained marketable for five days after removal. The chief difficulty encountered was the cracking of the skin and wilting. In closed containers, at 32° F., cracking and wilting were lessened, and the fruits kept for 85 days.

The Kaki or Japanese Persimmon.

According to storage trials at the California Experimental Station (30), Persimmons (Japanese) were held at a temperature of 32° F. for two months—upon removal from storage they remained marketable for a period of eight days.

Nuts.

Walnuts, almonds and pecans, have been held both shelled and unshelled, for periods of four years in cold storage, with only slight deterioration in the flavour. Storage at 32° F. gave the best results, the depredations of worms [22]—a major evil of these commodities in storage—being successfully held in check.

Bananas.

Bananas of the Gros Michel variety are carried in well-ventilated holds at a temperature of 53° to 54° F. On arrival at their destination, they are conveyed to ripening rooms of high humidity (90 per cent.), and a temperature between 70° to 80° F., according to the rapidity with which they are to be ripened to meet the market demand for ripe fruit.

Figs.

According to the *Revista Commerciale Itala-Americana*, a new method of treatment [43] is being applied—the figs are immersed twice in a preparation with a paraffin basis (for large quantities a rolling carpet machine is used). In this way a rigid envelope is formed around the fruit, which prevents loss of aroma by evaporation. The paraffin substance is quite inoffensive and is removed with the peel—there seems, therefore, no objection from the hygienic point of view. In this way, a delicate and highly perishable product may be put on the market in excellent condition, despite long journeys.

Good results have been obtained with figs stored at 32° to 34° F.

Concluding Observations.

I. The storage temperature, and the commercial storage life at these temperatures, are given for a number of fruits and vegetables either indigenous to, or which may be grown in, the tropics.

II. The maximum and minimum temperatures for safe transport, which would be valuable to prospective shippers, are given in a few instances only, as unfortunately, the shipment of vegetable food products of tropical origin over long distances has received comparatively little attention; accounts of storage trials give, as a general rule, little more than the commercial storage life of a commodity at one particular temperature; in transport, the storage chambers should be maintained at as near that temperature as possible. Experiment will later define the margin of safety.

III. With cargoes which are to be carried at low temperatures (32° to 40° F.), pre-cooling of the fruit at the Harbour cold store, immediately prior to shipment, is very strongly recommended.

IV. In storage compartments, particularly where refrigeration is effected by exposure to cold brine pipes (stagnant cold air as opposed to the cold air blast system), the use of "dunnage"—thin strips of wood nailed on the crates—to allow of the passage of cold currents between successive tiers of crates, has proved decidedly advantageous.

V. Care in harvesting and packing, to avoid mechanical injury, is essential to consistent successful shipment. The determination of the optimum conditions of transport, by the often slow process of elimination of unfavourable conditions, has frequently been delayed unnecessarily, through failure to observe carefully this condition; for the purposes of experiment the use of material, other than carefully-picked, unbruised, thoroughly sound specimens, cannot be deprecated too strongly.

* * *

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SISAL AS FUEL.

According to the *Times Trade and Engineering Supplement*, No. 571, Vol. XXIV, it has been possible by means of a gas producer fitted to a six wheeler vehicle to allow it to be run with sisal poles only as fuel. These poles are the central stems of a plant left over after stripping off the valuable fibre used for rope-making purposes and so forth, and in appearance they are rather like bamboo, but are solid. The outer skin is extremely hard, while the interior is filled with a light substance resembling pith. The material has been only used to a small extent in Kenya for building purposes, and therefore there is a large accumulation of these poles for which a use hitherto has not been found. Cut into pieces of a few inches in length they can thus be employed as a means of running commercial motor-vehicles. A consignment was sent to this country in order to carry out the necessary tests, which, it is reported, proved very successful. Tests proved that 4lb. of sisal a mile were needed for moving the gross load of eight tons, a speed of approximately 20 miles an hour being attained on up-gradients. An examination of the producer and power unit at the end of extended trials is said to have shown these parts to be in a clean condition.

AGRICULTURE IN NORTH AFRICA.

By V. H. W. DOWSON, M.A., Dip. Agric. (Cantab.).

(*Concluded.*)

Plant Introduction.

THE sphere of activity in which the botanical service has become most well known is that of plant introduction and acclimatization. This, very largely, perhaps, owing to the activities of one who was not a member of the service, namely, M. Charles Riviere, who was in charge of the Magnificent *Jardin d'Essai* at Hamma, Alger, before it was taken over by the present government. This experimental station was founded in 1832, two years after the French first set foot in the land; but it was not until ten years later that it began seriously to assist the agriculture of the country. It took some time before it was generally realised by the French administrators that Algeria is not a hot country, but a country in which it is sometimes hot, and that attention given to the growing of potatoes would be more likely to produce useful results than attempts to establish sugar-cane and vanilla.

Vines.—There is a long list of plant introductions to the credit of the botanical services of the three countries, but the most important is the wine grape. No vineyards covered the hill slopes of Algeria, before the French conquest: to-day, four hundred and seventy thousand acres are so covered. To combat *phylloxera vastatrix* introduced with the vines in 1885, American stocks have been introduced; and most Algerian vines are now grafted on them. *Phylloxera* was first noticed in Tunisia in 1906, but has not yet been found in Morocco. In this country, on the French occupation, eleven years ago, there were already about fifteen thousand acres of grapes, but these were *dessert* kinds. French influence has been responsible for adding another five thousand acres of wine grapes.

Citrus.—The orange and tangerine industry occupies about fifteen thousand acres in Algeria; and is important chiefly in the Perrégaux district. Dr. Trabut has introduced the Washington Navel orange; but the benefit of this introduction has been less in the intrinsic value of the American fruit, than in its having caused growers in Algeria to realise that they themselves already possessed an excellent seedless orange (*Citrus aurantium aspermum*). Indeed, it is possible that the Washington Navel orange was growing on the shores of the Mediterranean, before it was ever named in the United States of America. It is unfortunately a fact that the orange trees of the Washington Navel variety bear well in Algeria only in the earlier part of their lives. It is to be regretted that more extensive and more extended trials were not undertaken before Algerian citriculturists were encouraged to plant up their orchards exclusively with this variety.

Figs.—The fig is one of the commonest fruit trees in Kabylia; but various improved varieties have been introduced for trial from other Mediterranean countries; and several of these are now in common cultivation. The Smyrna fig has been found to lose its distinctive flavour on being grown in Barbary. Smyrna figs grown in California also have been found to deteriorate in quality; so much so that they are known, not as Smyrna, but as Calymirna figs. * Caprification is practised in most of North Africa. It is interesting to note that as long ago as the twelfth century, Ibn Al Awan gave as the reason for this practice the one most commonly given to-day.

Prickly Pear.—The Prickly Pear (*Opuntia Ficus-indica*) or "Prickly Fig" of the Arabs and "Barbary Fig" of the French, was introduced into North Africa a great many years ago, and now luxuriates over a wide area.

Shade trees.—The list of plant introductions into Morocco, Algeria, and Tunisia is formidable, and includes a large number of market garden crops, perfume plants, fruits, drugs, cereals, and other plants. One class of plants introduced, however, must be mentioned, namely, shade trees. The traveller who visits the towns of Alger and Tunis from the sea at once is impressed by the avenues of planes, limes, and *ficus*; but of greater importance is the work of shade production in the South. False Pepper Trees (*Scinus Molle* and *S. terebinthifolius*), introduced from America, line the dusty roads; and the Soap Berry Trees (*Sapindus Saponaria*, and *S. marginatus*), first introduced about sixty years ago, cast their grateful shade on the fringes of the oases.

A large number of *eucalyptus* varieties have been tried from time to time, and *E. Globulus* and *E. rostrata* are common. A large plantation of the former at Ain Regarda near Constantine was killed by the severe winters of 1915 and 1917.

Two native hybrids, *E. Trabuti* and *E. algeriensis* appear well suited to local conditions.

The Canary Island Pine (*Pinus canariensis*) does well in the neighbourhood of the coast. In the South, the antipodal *Casuarina equisetifolia* is an excellent shade tree.

Curiously enough, in the drier regions, very little use seems to be made of the native tree tamarisk (*Tamarix articulata*; Arabic, *Athal*), although it has been introduced into Arizona and California, where it is proving a valuable shade tree and wind-break. Leguminous trees and ornamental shrubs have been introduced with success, such as *Poinciana gillesii*, and various species of *acacia*.

The handsome shade tree, *Phytolacca dioica*, has been brought to the *Jardin d'Essai* at Rabat from central South America; and it will be interesting to follow its history in its new home,

* Hastening of ripeness in figs by subjecting them to puncture by wild-fig gall insects.

for it is reported as being of a species extraordinarily resistant to long periods of drought. It has the disadvantage of killing plants beneath it.

Cotton.—Before ending these notes on the work of the agricultural departments in introducing and testing new crops, brief mention must be made of Algerian experience with cotton. Although Pliny makes a reference to what might be cotton in Barbary, and though the Arabs, as may be seen from the *Kitab Al Falahah* of Ibn Al Hussain, most certainly cultivated it, yet, on the arrival of the French, there was no cotton grown in the country, except a few scattered bushes here and there in gardens. The conquerors shortly introduced Egyptian, American, and Sea Island cottons, and encouraged their culture. Seed was provided free, ginning and export charges were borne by the State, and large money prizes were offered to the best cultivators. So successful was this policy, that, by 1858, there were about five thousand acres under cotton in Algeria. This figure was never reached again, for, as soon as the State withdrew its financial aid and left the industry to stand alone, the area under cotton shrank to an insignificant amount, except for a short period during the War of Secession, when high prices caused a temporary boom. Since the beginning of the century, the government has been making further efforts to establish the cotton growing industry. An experimental station, to concern itself chiefly with cotton problems, has been founded in the centre of the cotton district at Perrégaux, and grants of land have been made to intending cotton growing companies. A Cotton Co-operative Society has been organized at Orléansville, and gins the cotton for the growers. However, after three-quarters of a century of trial and encouragement, in 1920 there were produced in Algeria only two hundred and forty *tonnes* of ginned cotton. It is not easy to discover the reasons for this lack of success from Algerian official publications, for the latter refuse to recognise a failure; but it seems not improbable that the reasons are entirely climatic. Cotton needs intense summer heat and abundant summer water. In Algeria, where there is enough heat, there is hardly any water; and where there is enough water, there is hardly enough heat. However, a company with a million francs capital has been recently formed for working an allotment of three thousand acres near the desert oasis of Tolga. A third of this estate will be under cotton each year, and water will be provided by an artesian well. It is possible that this enterprise, undertaken further south than the others, may have more success.

The principal varieties grown are Mit-afifi, Nubari, Abassi and Yannovitch, although it is realised that Egyptian cottons need more water than Americans; and, of these, Mit-afifi appears to be the favourite. Yield and profits appeared to be so much a matter for animated discussion that the writer confesses himself ignorant of what they are.

In Tunisia, where the example of Algeria always has been found valuable, cotton cultivation has been recommended only guardedly, and more vigorously, perhaps, ten years ago than to-day. The area under this crop is negligible at the present time. Varieties tried have been Assil, Mit-afifi, Abassi, Yannovitch, and Sakelarides of the Egyptians; Brown and White Biancavilla of the Sicilians; Mississippi, King, and others, of the Americans; and various Turkestans; but the chief activities of the research staff are directed now towards other crops.

In Morocco, also, although the garden cultivation of this fibre simply for stuffing cushions and mattresses has been known from antiquity, yet its cultivation to-day is but little extended, and this despite government experiments undertaken since 1913. The rainfall in Morocco is very different from that of the cotton belt in the United States of America, with its early summer rains, and occurs often when the bolls open, spoiling the harvest. Spring and autumn frosts are equally disastrous. In the South, under irrigation, the results have been good, but irrigable land is scarce.

It has been estimated that about one hundred and fifty thousand acres of land in the valley of the Sebou would be suitable for cotton; but, even if only a third of this area were under the crop at once, yet the necessary hydraulic works would be extensive. Finally, the population of Morocco is thin, and more anxious to keep flocks than to cultivate cotton.

Other Activities.

Investigation into plant and animal diseases is an important part of the research work of the three departments. Grape vine diseases especially have engaged their attention; but maladies of all the chief crops have been studied, and preventive or curative measures made known to the farming public. Entomological and mycological bureaux are to be found at Alger and at Tunis, and the departmental bulletins are the depositories of much original research in these fields.

The breeding, care, and diseases of sheep are being studied at the Veterinary Experimental Station at Tadmit; while similar work on cattle is being carried out at Fez. Indian cattle (*Sindhi?*) have been crossed with the local Moroccan cattle, animals indistinguishable to the unpractised eye from those of the 'Iraq, with the object of improving the milk yield of the natives. Although the experiments are in their initial stages, they seem to have been successful. There has been considerable work on sheep diseases, for information about which the works of Messrs. Geoffroy Saint-Hilaire, Scurat, and Railliet may be consulted.

The Experimental Station at Tadmit is concerned entirely with problems connected with sheep raising. There are six flocks, five experimental, and one consisting of the rejects from

the others, purely commercial. The five experimental flocks are composed of individuals of the main races of Algeria (1) local Tadmit sheep, improved since 1918, horned; (2) R'ambi, with brown heads, rams horned; (3) Zahrez, with white heads, rams horned; (4) Zahrez, with white heads, rams hornless; and (5) Harazlia, with red heads, rams horned. In the first place, the station demonstrates that a little cultivation to provide fodder to supplement the natural pasture in dry summers saves the considerable loss which flock owners suffer. Secondly, an exact study is being made of the points and qualities of the local breeds. Thirdly the flocks are being improved by rigid selection, so that they may form stud flocks for the improvement of Algerian ovines as a whole. There are also experiments in progress concerned with shearing, castration, and diseases.

Research in agronomy is not neglected, and the bigger stations are equipped for dealing with inquiries into cultural methods and soil science. New machines are tested on Government Farms, before their use is advocated. It is owing to the energy of the Algerian Department of Agriculture, Commerce and Colonization that the espicadora has been introduced into North Africa. First tried at the farm at Berteaux, it has shown itself valuable on the steppe, wheat lands of the Tell, where it reaps twenty-five to thirty acres a day. Various makes of tractors have been tried at Maison Carrée and Berteaux, and the results made available for the information of colonists and prospective purchasers. Windmill Pumps have been tried. They are recommended only for garden irrigation, where the water to be lifted is close to the surface of the ground. The most satisfactory method of employing them is to use them for filling large masonry tanks resting on the ground, and to run out the water stored in them, when the garden has to be irrigated.

In Algeria, since 1846, efforts have been made to establish the silk-worm industry, and, in Tunisia, since the French occupation, but, in both countries, without much success. When the Algerian Government gave away the eggs free and bought the cocoons, the cultivation spread; and, in 1853, over thirteen *tonnes* of cocoons were produced. When, however, the Government stopped giving its aid, the cultivation languished; and is now insignificant. The same has been the experience in Tunisia. The native does not seem to give the attention to the worms that is given in Italy; and the industry cannot compete with the silk imported from that country or from India and China.

An account of the work of the date experiment station of Algeria will be found in another report.*

Colonization.

Most of Barbary has a climate very little hotter in summer than Spain or Southern Italy; though that of the land to the South of the mountains is similar to that of the 'Iraq. The consistent aim of the French administration has been to encourage the immigration of Europeans, and especially of French people, from whose activities the rapid exploitation of the country is expected. Reduced railway fares in France from the home of the intending emigrant to Marseille, reduced passage fares across the sea, and the sale of land in Barbary below market price, encourage the Frenchman to seek a home on the southern side of the Mediterranean. The Frenchman, however, does not leave his motherland so willingly as the Englishman; but, as a result of these inducements, and of the nearness of the metropolis to Barbary, the latter now contains large numbers of colonists. About thirteen per cent. of the population of Algeria was European in 1911, and about eight per cent. in Tunisia. In French Morocco, in 1918, Europeans formed about one per cent. of the population. Taking Barbary as a whole, it may be said that there is about one European to every twelve natives.

In Algeria, the increase in European owned land very largely is caused by the purchase of land by colonists already in the country or by their descendants: in Morocco, colonists have only just begun to arrive; but in Tunisia, immigration is active. Most of the *habus* (*i.e.*, *waqaf*) land has been sold to immigrants, and the State is busy acquiring new land for the same purpose. Settlers pay for their holding in ten annual instalments, and have to carry out various, stated improvements, before their title deeds are handed to them. When several blocks close to each other in a new district are sold, the Government builds the necessary public buildings and the roads of the new village.

Apart from the political significance of a large French population amongst the native Muhammadans, the benefits which accrue to the country of an agricultural sort are immediate and direct. The French-speaking colonists form centres for the dissemination of the knowledge of European agricultural practice, and for the distribution of improved varieties of crops and stock. The Tunisian cultivator, when his olives are smitten with *Capnodium* or *Lecanium*, does not consult the nearest agricultural officer on cause and cure; but the European colonist is much more alive to the danger of losing his crops by unchecked parasitism, and is ready to seek advice from the department. His Tunisian neighbour, who himself would not trouble to go to the town to make inquiries about the fungus disease, when he sees the colonist on the adjoining plantation successfully spraying his olive trees, often follows suit. In the same way, agricultural machinery, first used by the colonists, afterwards is adopted by his neighbours. The colonists' sons are to be found in the agricultural colleges, and these, returning to the parental homesteads, or founding others, leaven the whole agricultural practice of the country. It

* Not specified—Ed.

is to these facts the writer believes most of the agricultural advance made in Barbary during the last half-century can be traced.

Education.

The various schools and colleges in which agriculture is taught have been enumerated already. All that is here necessary to do is to draw attention to the emphasis which the administrations place upon this type of education. The fame of Maison Carrée has spread far, and students have come to study there from Egypt.

Apart from agricultural education in the narrower sense, the departments' activities are directed largely towards the education of the whole of the agricultural community in methods of making the land yield more and more. The practices found useful at the research institutions are popularised by the agricultural inspectors, and, very largely, as indicated above, by the more progressive colonists.

The results of the research workers, when available, are popularised by the district agricultural and veterinary officers, and, as already mentioned, by the numerous agricultural schools and colleges. The colonists of European extraction, as has been indicated, are usually the first to avail themselves of improved methods and appliances. This propaganda work is the extension of the more purely academic of the educational work carried out by the departments, and both follow logically from the foundation experimental work.

The departments are responsible for the inspection of plants and live stock entering and leaving the countries in order to prevent the spread of agricultural pests and diseases.

It is difficult to know how far their efforts are successful. Certainly, before this inspection was organised, *Phylloxera* entered Algeria, while in Morocco, where vines have not been imported until after the time when the department began to control such imports, this pest has not yet been found. On the other hand, plant inspection was the rule in Tunisia in 1906, when *Phylloxera* entered the country.

Conclusion.

If the characters of each of the three provinces of French North Africa had to be distinguished by one word, Morocco might be called the land of *Stock*, Algeria of *Vines*, and Tunisia of *Olives*.

Cereals and dates also are important. These countries are less suited to a mixed, or self-supporting agriculture, than to the production, on a large scale, of special products, for example, leather or wine, which have to be exported and exchanged for the other necessaries and luxuries of life. In other words, for the most use to be made of the land, and its special climatic conditions, trade must flourish. Such flourishing trade was characteristic of the Punic era and of the later times, when the *Pax Romana* reigned in the Mediterranean. Then, for fourteen hundred years, Barbary was the battle-field of Vandal, Byzantine, Arab, Berber, Spaniard, Portuguese, and Turk and it is only since 1830, when the French first set foot in "Africa Minor," that peace and prosperity have begun to reappear. By the establishment of interior security, there has been provided the opportunity for the development of the land, and, at the same time, the world's markets have been thrown open to the African producer.

The Republic has pursued its policy with energy and decision, lucky in the help received from men of the stamp of Bugeaud. It is in Algeria that French influence has been longest at work, and it is Algeria that shows the greatest development; and the often quoted statement, *Le chef-d'oeuvre colonial de la France, c'est l' Algérie*, is surely no unfavourable criticism of France's other colonies.

Throughout these notes, the writer has consistently approved the change that has passed across the face of Barbary; the metalled roads, where, before, there were but tracks; the vineyards, where, before, there had been scanty sheep pasture; the great fields of uniform corn, in place of the irregular patches of mixed grain; the artesian wells and flourishing oases, in place of the bare and sandy desert; but he constantly has found himself wondering whether he has not placed too much emphasis on the material things of life, and too little on the less tangible things which men want, such as freedom. One hot day, journeying across the Sahara, from Biskra to Sidi Okba, in a villainous conveyance, called a *carossa*, and resembling the omnibus which plies between Musayib and Karbalah, the writer asked his neighbour whether there was any religious chief in Algeria, comparable with the Khalifah in Turkey, or with the Sharif of Mecca in the Hajaz. The reply came, with a bitter laugh, "Who is the head of our religion? Why, it is *Monsieur le Gouverneur Général de l' Algérie.*" Islam realises the wealth that Christendom has brought to Barbary, but it does not hate it any the less.

CHLOROSIS IN FRUIT TREES.

THE phenomenon of chlorosis (or scarcity of chlorophyll) is not uncommon on calcareous soils, and it is generally recognised that it is usually due either to scarcity of available iron or to immobility of this metal in the plants. In commercial practice it is not always easy to remedy the condition. This is most often done by spraying with iron salts, and more than half the pineapple crop in Hawaii has to be treated in this way. T. Wallace (*Jour. Pomology and Hort. Sci.*, 7, 251-260), continuing his investigations on chlorosis of fruit trees, now finds that much more certain improvements can be produced by growing cover crops over the roots of the affected trees. Any danger of nitrogen starvation can be removed by suitable fertilisers.—(*Nature*, No. 3,115, Vol. 124.)

COCONUT NOTES.

The Floral Biology of the Palm.

The advantages to be obtained from the use of planting material of known parentage, and the difficulties of obtaining such in the case of the coconut palm, have led several workers to investigate the sequence of events in the flowering of this crop, and the biology of its pollen, in the hope of establishing some practicable methods of controlling fertilization.

The latest contribution to the subject seen is an article by Maréchal (6) which adds some interesting details for Fiji to those previously published in Ceylon (8) the Philippine Islands (1), and Malaya (2), (3).

Experiments in Fiji.

Maréchal (*loc. cit.*) used palms of the Malayan Dwarf coconut (introduced to Fiji), the Fijian Dwarf or *Niu Leka*, and the *Rotuma* variety. The Malayan Dwarf appears from his observations to behave in Fiji very much as it does in Malaya according to Jack and Sands (3). That is to say that the male phase of the inflorescence overlaps the female, and was never observed to end before the female phase began, so that natural self-pollination is possible in this variety. Maréchal, however, thinks on the basis of his experiments that self pollination is not the rule in Fiji, whereas Jack and Sands are definitely of opinion that in Malaya it is the rule. In the other varieties under observation, the male phase was always found to finish from one to five days before the female phase began, and there was never sufficient overlapping of successive inflorescences to permit any self-pollination.

The period from the opening of the spathe until the first female flowers were receptive was found to vary from nine to thirty-two days in *Niu Leka* and from five to twenty-three days in Malayan Dwarfs.

Extensive tests were made of the viability of pollen under different conditions of storage, and a convenient method of pollen collection is described. Of the various media used for germinating the pollen to test its viability, the most satisfactory was 25 per cent. sucrose solution with 4.5 per cent. gelatine. The best storage results were obtained by keeping the pollen in full light in a desiccator over sulphuric acid of 30 to 40 per cent. strength. Under these conditions from 35 per cent. to 60 per cent. of the grains retained their vitality for at least 16 days.

Maréchal claims that one of his experiments demonstrated that "coconut pollen requires light to keep alive, and full daylight at that." This can hardly be taken on the published figures as well-founded without further proof. Pollen is capricious material to handle at all times, and safe generalisations about its behaviour can only be drawn from long series of experiments.

On the question of natural pollination, Maréchal agrees with other workers that both wind and insects play a part, but regards bees as by so far the most important pollinating agents as to be essential for high production of nuts.

It is not clear from the tables of results of pollinations that any controlled selfing with stored pollen was actually done, but artificial crosses were made with successes averaging about 30 per cent. and the technique used is described.

Experiments in Trinidad.

During the Session 1927-28, H. A. Pieris, a post-graduate student, carried out in the Botanical Department of the Imperial College of Tropical Agriculture a series of pollen tests similar to those of Aldaba (1), Furtado (2), and Maréchal. The number of palms available for the work at the time was small, and the results, embodied in a Dissertation presented for the Associateship of the College, were not published. It now appears, however, that observations in Trinidad may be of wider interest for comparison with those in Fiji and elsewhere, and the following short account has been compiled from the Dissertation in the College Library in order to make them available.

The trees used were a group of eight, about nine years old, and of the common Trinidad kind. Pieris found that the interval between the opening of one spathe and the opening of the next varied from 25 to 37 days. The interval from opening of the spathe to receptivity of the first female flowers was from 19 to 24 days, and no case was observed of an inflorescence opening before the female phase of the preceding one was over, or of any overlapping of male and female phases in the same spadix. Cross-pollination is therefore apparently the rule in Trinidad.

To assess the relative importance of the natural pollinating agents, Pieris made an attempt to separate the effects of wind, crawling insects (red and black ants were the chief crawling insects noted on trees), and flying insects. The flying insects observed in inflorescences were *Apis mellifica*, *Polistes annulatus*, *Musca domestica*, and a small black beetle. These were easily excluded by bagging emasculated inflorescences with a rather wide-meshed muslin, which would not interfere seriously with wind-borne pollen, but the separation of wind and small crawling insects such as ants is less easy, and the method adopted, viz.: bagging with a very fine muslin bag tied loosely round the bottom of the spadix, cannot be claimed to be satisfactory, as wind-borne pollen was probably not entirely excluded.

Nevertheless, the results are of some interest. In waxed bags all flowers shed in a few days, but the dark, humid conditions inside the bags may have been as much responsible as the complete exclusion of pollen. In fine-meshed bags ten flowers set nuts out of 156 enclosed, or six per cent.; from general observations it is

concluded that these were probably due to imperfect exclusion of wind-borne pollen, and not to ants. In coarse-meshed bags, out of 70 flowers enclosed, 22 set nuts, or 31 per cent. When emasculated inflorescences were left freely exposed, 42 flowers out of 108 set nuts, or 39 per cent.

Pieris concludes that wind pollination can only be as effective as it evidently was in this experiment, at fairly close quarters. This opinion he confirmed by repeating an experiment of Aldaba's, and exposing vaselined plates in different positions to catch wind-borne pollen. A plate exposed in the axil of a leaf on a tree adjacent to one which was shedding pollen at the time caught a few grains (the exact number is not stated) but in a second case where the source of pollen was two trees away, only three or four grains were collected in four days.

Fresh pollen was observed to contain a certain proportion of small and irregular grains, varying in different samples from 4 per cent. to 26 per cent. This agrees with Aldaba's findings, of abortive grains in proportions ranging from 3 per cent. to 33 per cent. in all the cultures he made. It may prove on further investigation to be a point of some importance.

The medium used by Pieris for germinating pollen as a test of viability was a sucrose solution made up freshly for each series of experiments, boiled to sterilize it, and cooled before use. This was employed in hanging drop cultures. The optimum concentration was 25 per cent.—giving usually over 80 per cent. germination, with 20 per cent. and 30 per cent. sucrose not greatly inferior. As high a germination percentage as 14 per cent. was obtained in a 5 per cent. solution, showing that coconut pollen is fairly tolerant in its requirements.

Comparisons made between pollen stored over calcium chloride in a desiccator and pollen stored in gelatine capsules indicated that whilst the loss of viability after eight days was considerable in both cases, it was less in the gelatine capsules than in the desiccator. The best germination percentages on the eighth day were 49 per cent. for "capsule" pollen and 22 per cent. for "desiccator." After this, however, the capsule pollen rapidly deteriorated, and gave germination (7 per cent. only) in only one set of experiments out of eight on the 16th day, and none at all on subsequent dates. Desiccator pollen, on the other hand, although rather erratic, continued to give small percentages of germination until the 31st day. The best samples gave 34 per cent. on the 16th day, 15 per cent. on the 18th day, 9 per cent. on the 27th day, and 4 per cent. on the 31st day.

Artificial pollinations were carried out both with fresh pollen and with stored pollen. Fresh pollen set six nuts from 38 flowers pollinated, pollen kept seven days in a gelatine capsule set two nuts from 11 flowers, and pollen kept seven days in a desiccator set three nuts from 14 flowers. These numbers are admittedly small, and it is unfortunate that it was not possible at the time to test pollen stored for longer intervals, but the figures are quoted because in the third case mentioned the three nuts were set with pollen from the same inflorescence, collected before the male flowers shed. The possibility of artificial selfing of coconuts in Trinidad was thus definitely established.

General Consideration.

As there are now several accounts of the floral biology of the coconut palm in different parts of the Tropics available for comparison, it may be useful if a short summary is given here of the state of knowledge to date.

Production of inflorescences.—The average rate of spadix production is sometimes stated to be about one per month, and this may perhaps be used as a rough rule, but there is so much variability that a general average based on several sets of observations in different places can be of little value.

The shortest average interval between successive inflorescences yet recorded is 20 days, for dwarf coconuts in Malay ([5]), and it would be interesting to know whether this variety is genetically different from tall kinds in this respect, but there is no record available of any comparisons between the two types under similar conditions. In an earlier paper ([3]) based on observations of a different set of dwarf palms (which, by the way, are described as "not well cared for") the same authors give a table from which the average interval works out at 24 days, and this is not significantly different from the average interval of 25 days calculable from one of Aldaba's tables for two tall palms in the Philippines.

Such difference in behaviour between two sets of palms of the same variety may fairly be adduced as evidence of a general effect of environmental conditions, and perhaps even stronger evidence is afforded by the remarkable variations in interval exhibited by any single palm in the course of a few months. Petch ([8]) for example, observing one palm at Peradeniya, found intervals ranging from 24 to 58 days. This example is selected from many available because Petch notes that the longest interval occurred in the driest months, whilst the month of the shortest interval (May) is usually hot and moist at Peradeniya. He adds, however, that in general the intervals are not governed only by rainfall.

The relationship of spadix production to general growth conditions does not appear to have been anywhere worked out in detail, but from the observations of Mason and Lewin on the Oil Palm in Nigeria ([7]) and from consideration of the fact that there is normally a spadix in every leaf axil, we should expect the rate of

flower-bud formation to be determined by the same factors as the rate of leaf formation, whilst the later development and opening of the inflorescence are likely to be governed by additional factors.

Number of female flowers per spadix.—All investigators report wide variability in this character, Furtado putting the extremes at zero and three hundred, whilst Sampson ([10]) records having counted up to 235. No data have been found which show how much of this variation is due to genetic differences between palms, but the evidence for seasonal fluctuation is abundant.

Maréchal records a tendency for Malayan dwarf coconuts in Fiji to produce more female flowers in the inflorescences which open from November to March than in those opening during the rest of the year, and there are similar notes in other papers. The most detailed record is that of Sampson, who gives a graph showing very definite seasonal fluctuation on the Malabar Coast of India, and suggests a correlation with climatic conditions which in broad outline is probably correct. More detailed work still, based on an exact determination of the length of time which it takes for the bud to develop from its first initiation, would probably disclose some interesting features of the physiology of the palm, with an obvious bearing on the question of final yield.

Percentage of flowers forming mature nuts.—This probably depends upon three sets of factors, viz.: (1) the genetic constitution of individual trees (2) the conditions governing pollination and (3) the general condition of the trees at the time.

So far as the first set of factors is concerned, we know from the work of Jack ([1]) that individual palms possess an inherent capacity for high, low or medium bearing, and it seems reasonable to suppose that inherent capacity for high, low or medium setting of fruit may be one of the causes contributing to final yield, but we have no information more definite than a statement by Sampson to the effect that some trees never produce a large number of female flowers, but at the same time set a high proportion of them, with the result that cropping is relatively steady, whilst other trees are very irregular in bearing.

The general condition of the tree, and its relationship to the fall of immature nuts after these have been properly pollinated, does not properly belong to our subject, and the conditions governing pollination demand a separate heading.

Conditions governing pollination.—The question of prime importance to the coconut breeder, and one which has been widely discussed, is whether the palm is normally self- or cross-pollinated. This question may be simplified at the outset by removing from the discussion the dwarf coconut of Malaya, which has been shown fairly conclusively by Jack and Sands to be chiefly self-fertilized in Malaya, and by Maréchal to have at least the potentiality of considerable natural selfing in Fiji.

From the sum of observations on other types, it is quite clear that cross-pollination is the general rule, but opinion still varies about the amount of self-pollination that may take place. In some localities the latter method appears to be entirely ruled out, whilst in others the case is different. Self-pollination, when it does occur, may result from overlapping of the male and female phases of the same spadix, or, probably more commonly, from overlapping of the female phase of one spadix with the male phase of the next on the same tree. The points of importance therefore are the interval between inflorescences, the onset and duration of the male phase, and the onset and duration of the female phase. The indications are that each of these is affected by environmental conditions. Warmth and humidity appear to accelerate the onset of the phases, perhaps especially the female phase, so that in the lowlands of Malaya, for example, this phase may begin before the male ends. On the other hand, a lower humidity favours the retention of vitality by the pollen, so that there may sometimes be the possibility of female flowers being fertilized by pollen from male flowers of the same inflorescence which have already dropped.

Accepting cross-pollination as the rule, we come next to the question of the pollinating agents. Here there is general agreement that both wind and insects play a part, and that wind is only effective at fairly short range. Further, there is a striking similarity between the lists of insects observed visiting the flowers in different parts of the world. All observers place bees at the head of the list in importance and add other Hymenoptera; nearly all report the common house-fly or a closely allied species, and several add at least one species of beetle but assign little importance to it.

Artificial pollinations.—From what has been said, it will be evident that any attempt to control the parentage of seed nuts must involve protection of the flowers against foreign pollen. This means that the spadix must be emasculated and bagged, and a bag which safely excludes all possibility of contamination by wind-borne pollen may be rather unfavourable to the setting of nuts. Possibly this accounts for the rather poor results obtained by some workers with artificial pollination. Apart from this, there is no difficulty in making crosses if the desired pollen is available, but if self-pollinations are required, or if the right pollen for a cross is not available at the right time, recourse must be had to storage.

Keeping qualities of pollen.—Taking the results of all investigators together, it is clear that under some conditions coconut pollen will keep for about a week without any special precautions.

The length of its life, however, may be greatly increased and rendered more certain by controlling the humidity of the atmosphere, which is probably the most important factor. In an atmosphere saturated with moisture, the grains lose their viability in a few hours, whilst at the other extreme of humidity the majority lose their viability over calcium chloride rather faster than undesiccated grains, though a few remain alive for at least a month. The optimum condition lies between the two, and the best results for practical purposes are those of Maréchal, who, as mentioned above, obtained germinations of 35 per cent. to 60 per cent. after sixteen days by storing over 35 per cent. sulphuric acid.

Pollen culture.—Even under careful conditions of storage, pollen will always vary and it is therefore necessary to test samples before use. This can be done by germinating the grains in a sucrose solution, and the optimum concentration has been found by several to be 25 per cent. although germination is obtained in all concentrations from 5 per cent. to 30 per cent. In conclusion, it may be stated that the best results to date, whilst serving immediate practical purposes, are sufficiently irregular to indicate a need for still further investigation of the biology of coconut pollen.

E. E. C.

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UGANDA SUGAR FACTORY.

The Lugazi factory in Uganda now has something over 5,000 acres under cane. This season about 1,500 acres were cut which have produced 4,000 tons of sugar. Mosaic disease is present in some of the fields but is under control and resistant kinds of cane are now being imported and planted.

ST. VINCENT COTTON.

By H. A. Ballou, M.Sc.,
Commissioner of Agriculture for the West Indies.

[*In April last at a meeting of St. Vincent cotton growers which was addressed by the Commissioner of Agriculture, a resolution was passed asking the Government to fix 1st September as the opening date for planting Sea Island cotton this year whereas, formerly, the planting season has opened in June and July. The following article which is a summary of the Agricultural Commissioner's address discusses briefly the causes which have led to the suggestion that it would be desirable to make a change in the date of planting.*]

Introductory.

At the end of the 19th century St. Vincent's two principal industries—arrowroot and sugar—were in a critical state. Like all the other West Indies, the island was suffering from the general depression in the Sugar Industry. The price of arrowroot, owing to overproduction, had, on the other hand, fallen to such an extent as to make the crop hardly remunerative. Also, in 1898, the island had been devastated by a severe hurricane, whilst its northern portion had further suffered from the effects of the volcanic eruption in 1902. Sea Island Cotton was introduced in 1903-04 and this crop which has occupied considerable areas of land, both under estate and peasant cultivation, was eventually responsible to a large degree for restoring to the Island the prosperity which it had lost.

Time of planting cotton.

Since the introduction of Sea Island Cotton into St. Vincent the usual practice has been to plant the crop in June and July with the result that the bolls form, develop and open at the time when the rainfall is at its highest. In certain localities with an average annual rainfall of 90 inches, it has been found that as much as 40 inches has fallen in the first four months after the cotton was planted with more than 20 inches falling in the following two months. The proposal for altering the date of planting to 1st September has been made in the hope of obtaining better results by extending the cotton season further into the drier parts of the year.

Cotton Yields in St. Vincent.

The highest average yields per acre for the island were recorded in the first few years after Sea Island Cotton was cultivated. In the six-year period, 1905-1910, the annual average yield ranged from 124 lb. to 174 lb. per acre, the mean for the period being 150 lb. The area planted ranged from about 800 acres in 1905 to about 3,500 in 1910. In the season 1911-12 with an area of over 5,000 acres the yield per acre amounted only to 96 lb., and in a period of eleven years, 1911-1921, the yield per acre only once exceeded

100 lb. In 1922, the yield per acre again rose to over 160 lb., and since that time it has gradually fallen off. St. Vincent cotton has always been noted for its excellent quality. The superfine St. Vincent has been, and is still, the finest grade of Sea Island Cotton being produced, while the St. Vincent ordinary also is a very excellent cotton. The comparatively low yields of St. Vincent cotton have been accepted by cotton planters as more or less inevitable as it is the common belief that with strains of cotton producing such fine quality of lint heavy yields could not be expected. Montserrat cotton, for instance, which is not so long and not so fine, has for many years steadily given higher yields per acre. The yield of cotton in St. Vincent, however, would appear to have been affected by other causes.

Relationship of yield to area of cotton planted.

In the six-year period 1905-1910 the average yield per acre for St. Vincent was about 150 lb.; the highest yield in the first two years of that period coinciding with the smallest areas planted. The higher yields per acre which have been obtained in the later years of the period under review, have also coincided with the comparatively smaller areas planted. It is not safe, however, to argue too much on the relation between small areas and high yields per acre, as in 1916-17, when an area of only 2,400 acres (smallest area on record) was planted, a yield of only 66 lb. per acre was recorded which proved to be the smallest yield per acre in any season during a period of 20 years. As a generality it may be assumed that with the larger area planted the greater amount of poor or indifferent land will be included, whereas in years of smaller plantings it would be expected, on the estates at least, that the poorer lands would be thrown out.

Relationship of yield to incidence of pests and diseases.

The smallness of the crop reaped is largely due to the loss of flowers and bolls, and this loss is to be ascribed to unfavourable climatic conditions and to the action of pests and diseases. The effects of insect pests on the yield of cotton in St. Vincent may be briefly summarized as follows. The cotton worm has been responsible for loss of crops to an extent that materially affected the acre yield for the island in only one or perhaps two seasons. Cotton stainers and pink bollworm have prevented reaping of a second bearing of crops. The stainers for several years (from 1911-1916) were so severe in their attacks that they appeared to threaten the very existence of the cotton industry in St. Vincent by greatly reducing the yield and preventing the development of clean white cotton towards the end of the first bearing. Since the campaign for the control of the cotton stainer was started in 1917-18 the losses due to this insect have decreased and for several years past have been negligible. The abundance of stainers at the St. Vincent Experiment Station gives a fair indication of the prevalence of this pest in the cotton fields of the island, and the following table shows the numbers of stainers collected by means of traps laid at the Station during the months of the Cotton season.

TABLE I.

MONTHS.	1922.	1923.	1924.	1925.	1926.	1927.	1928.
Jan.	135,909	37,878	20,086	1,449	2,850	—	26,298
Feb.	548,400	63,800	2,800	7,723	—	105	7,217
Mar.	129,660	51,880	930	6,231	791	1,072	909
Apr.	40,760	3,002	1,225	2,400	5,136	334	42,648
May	6,100	817	52	716	100	3,660	—
June	3,693	908	—	—	—	3,060	101
July	230	550	—	—	—	—	2
Aug.	209	87	—	1	—	—	705
Sept.	88	3	—	1	—	—	973
Oct.	89	8	—	—	—	—	758
Nov.	210	—	—	—	—	—	538
Dec.	900	377	57	550	—	150	—

In 1917-18 the results of the campaign were evident. Since that time the occurrence of large numbers of stainers has in each case been traced to carelessness or indifference in the matter of cleaning up or in the application of cotton seed for manure.

The first result of an adequate control of stainers was that clean white cotton was reaped in February and March, some two months later than had been possible previously. It is to be noted, however, that there has been no increase in the average yield for the island which might have indicated the benefits derived from this control. This is shown in Table 2 (p. 294). Stainer control was fairly complete in 1919. Crops were small in 1919, 1920 and 1921, and again in 1926 and 1927. In the four years 1922-1925 when yields were somewhat higher, the stainer control was no more efficient than during the five years just before and just after this period.

The pink bollworm has not caused serious loss of crop in St. Vincent. The stainers prevented a second bearing previous to 1917, and the pink bollworm has similarly prevented a second crop being reaped since 1924, but up to the time the first bearing of bolls has yielded its crop, the pink bollworm has not been abundant enough to affect the yield materially.

Relationship between yield and rainfall.

The persistent influence against the yield of St. Vincent cotton has been the rainfall and high humidity during the cotton season. The

means of the rainfall records for the months of October and November for 34 years show a rainfall in each of those months of more than 11 inches. The mean rainfall in August, September, October and November ranges from just under 11 inches in September to well over 12 in October. The June to January cotton season, over a ten-year period 1919-1928 has had the following rainfall:—

Month.	*Inches.*
June	8.48
July	9.42
August	10.49
September	8.53
October	11.63
November	11.25
December	6.69
January	5.87
Total eight months ..	72.36

Cotton planting extends from some time in June well into August, but even the late planted cotton, *e.g.*, that planted about the middle of August, will experience the effects of an excessive rainfall for some three and a half months. The direct effect of this heavy rainfall is the development of fungus and bacterial diseases:—mildew, angular leaf spot, black arm and bacterial boll disease and the *Phytophthora* rot or soft rot of the bolls. Earlier planted cotton has suffered to even a greater extent.

With the change of the planting season to September it is expected that the distribution of the rainfall will be more favourable to the development of a crop. A cotton season commencing in September would, on the basis of the average rainfall in the past ten years, receive rain as follows:—

Month.	*Inches.*
September	8.53
October	11.66
November	11.25
December	6.69
January	5.87
February	3.57
March	3.41
April	3.24
Total eight months ..	54.22

The average rainfall for the eight months of the new season would thus be 54.22 inches as compared with 72.36 inches of the former planting season. The figures for the rainfall in October and November and for the average crop per acre, show a fairly regular and consistent relationship.

The change in the planting season will be watched with interest. Early planting has been the rule for a period long enough for the probabilities of crop yield under certain conditions to be well known. The results from later planting should very shortly furnish definite information as to the value or otherwise of the change that is being made.

TABLE II.

Cotton production and Mean Rainfall figures for the years 1905-28.

Year.	Area planted acres.	Lint lb.	Av. Yield per acre lb.	Mean Rainfall October and November.
1905 ..	790	137,470	174	11·80
1906 ..	1,533	268,275	175	11·36
1907 ..	3,200	432,000	135	8·08
1908 ..	3,000	372,000	124	7·68
1909 ..	2,528	356,139	141	8·68
1910 ..	3,587	561,526	156	8·06
1911 ..	5,068	487,116	96	9·68
1912 ..	4,344	428,032	98	11·21
1913 ..	3,768	399,187	106	16·40
1914 ..	4,226	323,326	76	14·18
1915 ..	2,622	295,111	78	13·46
1916 ..	2,404	160,168	66	24·24
1917 ..	3,458	329,115	95	9·08
1918 ..	4,583	437,273	95	11·03
1919 ..	5,079	475,650	93	19·06
1920 ..	6,453	614,508	95	16·86
1921 ..	2,907	278,744	93	13·43
1922 ..	3,562	575,640	162	10·16
1923 ..	3,387	473,248	139	7·80
1924 ..	3,294	449,295	137	10·51
1925 ..	4,893	585,483	120	9·49
1926 ..	6,156	507,240	82	9·91
1927 ..	3,364	336,000	100	10·76
1928 ..	—	—	—	16·80

JAMAICA CITRUS FRUITS.

In view of the wide interest aroused both in Canada and Jamaica in the possibilities of citrus fruit production for the Canadian market, as a consequence of the cold storage accommodation in the new Canadian National Steamships, the Director of Agriculture stated in his 1928 Report:

"Citrus fruits showed a marked increase in the case of grapefruit, which rose from 80,000 to over 100,000 boxes. The Hope Nursery issued a large number of budded varieties of choice commercial varieties of oranges and grapefruits, besides many thousands of our special seedling strain of grapefruit. Hundreds of trees of these seedling grapefruits are now fruiting, and it has been found that the fruits are excellent and superior in flavour to the standard commercial grapefruits. Should any individual seedling trees be found unsatisfactory, it will be simple to bud them with a selected variety. I am satisfied that we have made no mistake in issuing these thousands of seedling grapefruit plants, and they will ultimately assist Jamaica to supply a cheap grapefruit of good flavour with which we should be able to enlarge our hold on the English and Canadian markets."

CACAO NOTES.

The relation between diseased cushions and the seasonal outbreak of 'black pod' disease of Cacao.

Studies were extended in 1927 on black pod disease of cacao with special reference to the mode of hibernation of the causal organism in the Gold Coast.

The results of a farm survey in two districts showed that the bulk of the infections occurring at the beginning of the season were definitely associated with the presence of deeply seated disease in the cushions, isolations from which yielded cultures of *P. palmivora*. There is no doubt, therefore, that the fungus can survive the dry harmattan wind season (December and January) in cushions, and that this is the principal and most effective method of renewal of the seasonal activity of *P. palmivora* as a pod pathogen.

Dissection of diseased cushions shows that the adjacent bark is more or less involved, with the formation of typical bark cankers, the infected portions of the cushions being continuous with the cankers. In the peduncle the affected tissues are of a water soaked, greyish-green tinge, with reddish edges and traversed by reddish lines. They become claret-coloured with age, then black and dry. When the peduncular trace is affected it turns first light brown and then black. From the cushion, infection proceeds into the surrounding bark, spreading vertically downwards for two or three (occasionally five or six) inches and laterally or upwards for a short distance.

In the cases of canker the diseased bark only became claret-coloured with age, apparently after the death of the fungus. In the early stages the presence of bark infection cannot be detected without shaving away the outer layers. The colour of the freshly exposed recently infected bark is a pale maroon, with brighter reddish-brown edges. This appearance is produced by numerous wavy red lines, between which the tissues are of a very pale pinkish-fawn colour. After a brief exposure to air the entire surface darkens to claret colour and the network of fine, zonate lines disappears. The canker penetrates the bark and blackens the wood.

Pod infection due to diseased cushions cannot be readily diagnosed by inspection but may be detected by lightly scraping the peduncle of suspected pods with a knife or the finger-nail, when the colour of the exposed surface is found to be greyish-green with reddish edges, traversed by red lines, instead of bright green. When the pods are infected from some external source, instead of becoming invaded by extension from the cushion, the peduncle shows no discoloration except in the most advanced stages. Infection from the cushion usually travels along the side of the peduncle adjoining the diseased part of the cushion, and, when it reaches the pod, spreads more rapidly laterally than longitudinally, mainly through the cortical tissues. The five vascular strands lying in the axis of the pod very soon turn black.

In normal trees five or six inches is about the maximum length of the cankers connected with diseased cushions. The few cases of serious canker injury observed in the Gold Coast have been associated with unusually unfavourable environmental conditions. The active stage of cushion infection, as described above, probably lasts two or three years, the cushion eventually becoming so much involved that fruit production ceases. The cushions become infected originally by extension into them of infection from a pod that has become attacked from some external source (*e.g.*, by spores). When all diseased pods are systematically removed, cushion infection is rare. Under such favourable conditions for the growth of the tree as in the Gold Coast, bark cankers in normal trees heal after some years. The dead bark rots away and the outer cortex cracks, dries, and curls inward into the cavity. The cushion also decays, leaving a shell of dried outer bark and fragments of peduncles. Cambial regeneration begins directly the canker ceases to spread and the renewal of the bark progresses rapidly.—(*The Review of Applied Mycology*, Vol. VIII, Part I.)

* * *

Trinidad Cocoa Planters' Association

A copy of the Annual Report of the Cocoa Planters' Association of Trinidad, for the year ended 30th June, 1929, has just been received. During this period cocoa sold realized $11.67 a fanega* gross, the net price paid to members, after allowing 12 cents for working expenses, being $11.55 a fanega. This was well over the average and under prevailing marketing conditions it would not have been possible to do better. It is disappointing to have to record that the year under review closed with cocoa selling at nearly $3 a fanega less than last year. The Deferred Deposit Fund now amounts to $45,461.56; $3,390.14 were set aside during the year to this fund. The cost of working the Association worked out at 8 cents a fanega, representing the very low charge of two-thirds of 1 per cent. Cocoa handled by the Association amounted to 58,182 bags of 165 lb. each, or an increase of 5,734 lb over the preceding year which was due chiefly to better crops being reaped by the majority of planters. The registered membership increased from 198 to 217, three estates being withdrawn.

The cocoa crop was well up to average in the Northern and Southern districts of Trinidad but was most disappointing in Tobago. The industry is at present passing through a period of uncertainty owing to the increasing activities of the oil industry, which is making inroads into areas of good quality cocoa, and to "witchbroom" disease. Although it is too early yet to predict the effect of this disease in purely agricultural areas, planters are asked to do all in their power to co-operate with Government officers in carrying out the measures of control recommended under the Plant Protection Ordinance. If these are carried out effectively there is no reason why the disease should not be kept under control.

* Fanega equal 110 lb.

SUGAR NOTES.

Compiled by the College Department of Sugar Technology.

New Method of Defecating Cane Juices.

In an article by G. H. de Vries in *Archief* 1928, 36, No. 11, instead of adding milk-of-lime to the juice, as is always done, the author, chemist to one of the Java sugar factories, has considered the alternative, viz., adding the juice to the milk-of-lime, a pH of 7.0 being the final reaction. In the usual method of treatment, at no time is the juice alkaline, but in the latter the neutralizing process commences in a strongly alkaline medium, which can only be beneficial in precipitating non-sugars which in the usual way are not affected. In order to obtain an idea of the way in which juices treated according to this new method may settle out, a laboratory test was made in which to 10 c.c. of milk-of-lime at 5°Bé. increasing quantities of juice were added without heating, the time being observed for 50 c.c. of precipitate to settle out from 100 c.c. Here are some of the results obtained together with figures for the alkalinity of the clear juice expressed in mgrms. of SO_2 per litre, using phenol-red as indicator :—

Milk-of-Lime used.	*Raw Juice added.*	*Time for Settling.*		*Alkalinity Mgrms., SO_2.*
c.c.	c.c.	Hr.	Min.	Litre.
10	500	3	40	323
10	600	1	20	198
10	700	0	30	106
10	800	0	10	38
10	850	0	5	0

Following this, comparative tests were made which more closely corresponded with the conditions of practice, and these are thus summarised :

	New Method.		*Old Method.*	
	Cold.	*After Boiling.*	*Cold*	*After Boiling.*
	c.c.	c.c.	c.c.	c.c.
Mud per 1,000 c.c. juice after complete settling	220	110	190	100
Appearance of the clear juice	almost clear		opalescent	opalescent
Colour of the juice	light yellow brown		light brown	dark yellow

Thus a better clarification altogether was obtained in these laboratory tests by the new method of working. There was a greater volume of precipitate, pointing to a more thorough elimination of impurities, and the juice finally obtained was both lighter in colour and clearer. It appears worth while to look further into this method of liming and especially to carry out some experiments on the factory scale.—(*The International Sugar Journal*, Vol. XXXI, No. 365.)

Mill Breakages.

Q. A. D. Emmen in *Archief*, 1929, 37, 1, No. 10, 315-321, states that during the 1928 season very many mill breakages occurred in Java, one factory, for example, breaking seven rolls during the crop, another six, two others, three, three others, two, and so on. Soerabaia sugar machinery workshops during May to October furnished 64 mill cylinders, 37 shafts and 75 mantels as replacements. Most of these breakages are said to have involved feed rolls. Different conditions which in milling may affect such a condition of things are the following : (1) a fall-plate improperly adjusted, acting as a kind of ram ; (2) a fall-plate having a very rough surface hindering the even passage of the bagasse ; (3) the fall-plate too short ; (4) rate of the rolls too low in regard to the quantity of bagasse to be worked ; (5) a front opening too small in relation to the cellulose milled ; (6) a front opening too small in proportion to the rear opening ; (7) a trash turner improperly adjusted, the distance between it and the top roll being too small or too great ; (8) unsuitable material for the mantel ; (9) faulty grooving of the mantel surface ; (10) irregular feeding of the cane carrier ; and (11) forcing too great a capacity for the same rate of the rolls. But the greatest danger for all mills is too small a back opening, the result being a powerful pressure on the top roll which may thus break.

E. C. von Pritzelwitz van der Horst challenges the statement that most of the breakages were feed rolls. He states that with milling installations with and without these feed rolls, there is little difference in the number of breakages. Thus during the season concerned there were 181 breakages in 388 mills with feeding rolls and 117 breakages in 279 mills without feeding rolls, or 47 and 42 per cent. respectively. These figures relate only to general mill breakages, but if they are confined only to roller breakages (excluding damages to mantels, shafts, bedplates, &c., as should be done) then the roll breakages without feeding rolls work at 77 per cent.—(*The International Sugar Jnl.*, Vol. XXXI. No. 367.)

* * *

Accumulations of Starch in Natal Uba.

According to a paper by D. M. Weller published in Vol. XXXII, No. 3 of the *Hawaiian Planters Record*, a correlation appears to exist between the juice purity of Natal Uba cane with the pH value of the soil on which it grows. If this variety is grown on an acid soil, excessive accumulations of starch are found in the stalks ; if grown, on an alkaline soil, however, such starch accumulations do not occur. Histological examinations made in the stalks of Natal Uba cane grown in Hawaii on a soil with a pH value of 5.3, and on a number of Hawaiian varieties also grown on an acid soil, demonstrated that there were two types of starch accumulations : the first occurring, without exception, in the upper part of the stalks of all varieties examined and the second, only in Natal Uba, and only in the mature portions of this cane,

WHITE GRUBS.

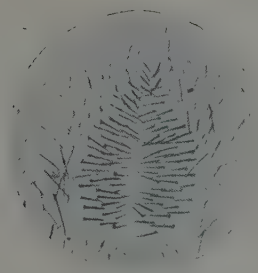

Fig. 10—*Arrangement of bristles on anal segment of 'Lepidiota frenchi' Blkb.*

Fig. 12—"*Glossy Scrub Chafer.*" (*Nat. size.*)

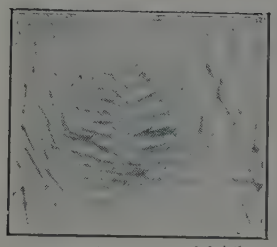

Fig. 13—*Arrangement of bristles on anal segment of grub of 'L. caudata' Blkb.*

Fig. 14—"*Dynastid Beetle or Red-Head*" (*Nat. size.*)

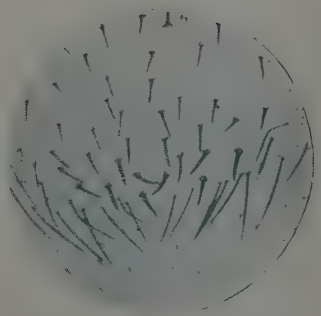

Fig 15—*Arrangement of bristles on anal path of grub of "Christmas Beetle."*

Fig. 16—"*Christmas*" or "*Golden Beetle.*" (*Nat. size.*)

AGRICULTURE IN NORTH AFRICA.

Cattle being loaded at Tunis for Malta.

BUD MUTATION IN COTTON.

(*See* page 275.)

CHEMICAL NOTES.

Compiled by the College Department of Chemistry and Soil Science.

Grass in Solid Form.

The Norwegian chemist, Thomas Gram, has worked out a drying process by means of which it is possible to produce a completely dry grass, which, in all respects, has the same qualities and the same nutritive value as fresh grass. It is an apparatus, originally developed for the drying and briquetting of peat, which has been adapted for use on grass. The grass is here obtained in the form of briquets. When being fed to the cattle, the briquets are mixed with a little water, and this fodder is enjoyed by the animals as much as fresh grass. It has been proved by feeding experiments that young, short-grown grass has a considerably higher nutritive value than older, long-grown grass. Thus one advantage of the invention is that the grass can be harvested and conserved in the most favourable stage of growth. Naturally, the number of crops per year can be increased correspondingly. The process has been worked out in England in collaboration with the Department of Agriculture of the University of Cambridge. Large quantities of grass briquets have been distributed among British farmers for testing, and their reports of the results of the practical feeding tests are very favourable. These experiments are to be continued in England. Patent licences have already been sold to several European countries.—(*Industrial and Engineering Chemistry*, News Edition. Vol. VII, No. 1.)

* * *

East Indian Archipelago Limestone Soils.

In *Communication* No. 14 of the Geological Institute of the Agricultural University of Wageningen, Holland, Prof. J. van Baren has presented in English the results of his investigations during the last thirteen years on the weathering of limestones and the formation of limestone soils in Java and other islands of the Dutch East Indies. Detailed qualitative mineralogical analyses are given for 21 rocks and for two mechanical fractions of 46 soils derived from them. Other soil data include colour by Lovibond's tintometer, mechanical analysis, hygroscopic coefficient, maximum water capacity, and reaction measurements by several methods. Full chemical analyses are given for a dozen soils and their underlying rocks. It is concluded that the properties of the soils are determined primarily by the composition of the limestone rock. Although the rainfall is important, the present knowledge of agricultural climatology is totally inadequate as a basis for the classification of soils and soil-forming processes. The analogies that have been drawn between the red limestone soils of the tropics and other red soils such as the Mediterranean *terra rossa*, are strongly criticised. The red colour shows nothing beyond the presence of some colloidal iron oxide of unknown origin, and gives no evidence that the soil has been formed in a humid tropical climate. It is claimed that the careful collection of facts must proceed for many decades before generalisations on the relation of soil to climate can have any value. Prof. van Baren appeals especially for detailed and systematic mineralogical research on the relation of the soil to the parent rock. He has been able to distinguish minerals formed within the soil from those derived from the parent rock or introduced by the action of volcanoes, water, or wind. The fuller study of such newly-formed minerals should reveal some of the chemical processes within the soil. Again, it is shown that apatite is rarely present in either soils or rocks, and cannot be the source of the phosphoric acid in these soils. Prof. van Baren's detailed notes, photomicrographs, and bibliographies on the minerals and organic remains identified will prove of great value in extending this type of work.—(*Nature*, Vol. CXXIII, No. 3109.)

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The Structure of Starches.

Recent advances in knowledge of the structure of starches have been made as a result of continued investigations at the British School of Malting, under the Directorship of Professor A. R. Ling (*Nature*, 20th April, 1929, p. 624). The starch of arrowroot, potato, &c., contains two main components, namely, amylose and amylopectin. The starch of cereals contains in addition, a third substance, amylohemicellulose. Whereas the two first-named substances are phosphate esters, the third is a silicic ester of amylose.

Hydrolysis of starch paste with barley diastase converts amylose quantitatively into maltose, whereas amylopectin yields soluble $\alpha\beta$-hexa-amylose, which in turn is resolved by malt diastase into various glucose derivatives. Amongst these are found isomaltose and glucosido-maltose.

Evidence has also been adduced to show that glycogen (a polysaccharide widely distributed in the animal kingdom, and also found in fungi and in yeasts), is not identical with amylopectin, although resembling it very closely.

* * *

Production of Rubberseed Oil.

A new industry developing in the vegetable oil field in the United States is that of rubberseed oil. First used for soap, it is now finding use in the manufacture of rubber substitutes, in the ink trade, and in place of linseed oil outside of the manufacture of soft soaps. Experiments in rubberseed meal have been carried on in the Federated Malay States, showing that no saponin or alkaloid is present. The cake is marketed chiefly in the United Kingdom and is used for cattle food.—(*Industrial and Engineering Chemistry*, News Edition, Vol. VII, No. 2.)

REVIEWS.

GREEN MANURING.—Its Possibilities and Limitations in Practice. Rothamsted Conference. *Ernest Benn, Ltd.* pages. 39. Price 2*s*.

This is a collection of papers read at a conference at Rothamsted by scientific workers and practical men having experience in the use of green manures as a means of maintaining fertility and improving mechanical conditions in the soil.

The practice of green manuring although possibly somewhat neglected in the past has in many cases been found to be an excellent substitute for farmyard manure since the curtailment of the arable acreage in Great Britain, and the consequent reduction in the amount of straw available for conversion into yard manure.

Conditions for growing crops for the purpose of systematic green manuring are not as suitable in northern Europe as in the tropics, and the United States of America. The main difficulties to contend with are

(*a*) unreliable seasons and the resulting difficulty in establishing a catch-crop during the limited time available.

(*b*) variations in soil and

(*c*) variations in cropping.

It is not desirable that a green manure crop should replace one of the main crops of the rotation, but rather that it should be in the nature of either

(*a*) a catch-crop, to be grown after an early-harvested crop (*e.g.*, mustard after early potatoes) or

(*b*) a crop inter-sown among a main crop in the spring (*e.g.*, red clover sown in wheat).

The relative merits of these two systems depend largely upon local conditions.

On poor light land lupins have been found to give excellent results and details gained from experience are given with regard to the management of this crop for green manuring purposes.

D. B.

* * *

PLANT DISEASES. — F. T. Brooks, M.A. (University Lecturer in Botany, Cambridge). *Oxford University Press*, 1928. Price 21*s*.

This book gives an up-to-date account of the diseases (non-parasitic, virus, bacterial, and fungal) of crop plants of British economic importance, including many which occur in the tropics. The diseases are very clearly arranged according to the pathogen concerned. The subject matter is brief but condensed, and each chapter is followed by an excellent list of references. It is a book which should be very useful to those possessing a mycological training, but is rather too advanced for the average planting community.

A. K. B.

THE PLANT IN RELATION TO WATER. By N. A. Maximov. Authorised English translation. Edited, with Notes, by R. H. Yapp. London. *George Allen & Unwin Ltd.*, 1929. Price 21*s*.

This is a book for the botanist, rather than the general reader unversed in Plant Pysiology, but for the former it combines the purpose of a valuable reference work with readability and much stimulation of thought.

It has several outstanding merits. First, as an able and critical summary of the many publications dealing with the absorption and loss of water by the plant, it takes its place alongside Stiles' "Photosynthesis" and similar monographs on special aspects of plant phsiology, in these days indispensable to the general botanist who cannot hope unaided to breast the full flood of current literature.

In the second place, a large proportion of the papers cited and discussed are recent Russian work, which is too often inaccessible to the English-speaking botanist.

Thirdly, the author had in mind in the conception of his book the special problems of agriculture in arid regions, which fact gives to his text a practical bias that widens considerably the circle of readers to whom it will appeal.

When Professor Maximov's book appeared in the original Russian, it was called "The Physiological Basis of Drought Resistance in Plants" and this phrase, retained in the sub-title of the translation, is the key to its point of view.

About two hundred pages are devoted to an historical account of the development of our knowledge of the relations of the plant to water, and a sure foundation is thus laid for a further two hundred pages in which the author expounds his views on the question, highly important agriculturally, of drought resistance. Incidentally, Maximov plays havoc with the common text book concept of xerophytism as involving always a reduction of transpiration, and it is here that he is most interesting and stimulating.

It should be added that the translation has been very thoroughly edited by the late Professor R. H. Yapp, who was peculiarly fitted for the work as being himself a leading worker in the same branch of physiology, and the rather numerous editorial footnotes are not the least valuable part of the book.

E. E. C.

PUBLICATIONS FOR SALE.

Copies of the following publications may be obtained on application to the Editor, Imperial College of Tropical Agriculture, Trinidad, B.W.I.

SUGAR COST ACCOUNTS ..By G. C. Skinner, Price 1*s*.

EXPERIMENTAL ERROR ..By E. J. Maskell, Price 1*s*.

THE SUGAR INDUSTRY OF THE WEST INDIES AND BRITISH GUIANA, WITH SPECIAL REFERENCE TO TRINIDAD ..By C. Y. Shephard, Price 2*s*.

COLLEGE NEWS.

Mr. and Mrs. A. G. Howell returned from Barbados by s.s. *Stuyvessant* on 31st August.

* * *

Mr. G. A. Jones, Assistant Commissioner of Agriculture, and Mrs. Jones returned to Trinidad by s.s. *Lady Nelson* on 5th September. During the course of a six weeks' tour of the Northern Islands Mr. Jones visited St. Kitts, Nevis, Montserrat, Antigua, St. Lucia and Dominica.

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Mr. A. Pickles who was one of last year's Empire Cotton Growing Corporation Students and is a graduate of Leeds University, has been appointed Entomologist under the Froghopper Investigation Committee. Mr. Pickles is expected to arrive on 21st September and will make his headquarters at the College.

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We extend our heartiest congratulations to Mr. H. H. Croucher, Lecturer in Chemistry, who was married on 8th August to Miss Beryl Francis Cooper, daughter of Mr. and Mrs. Arthur Cooper, at St. Giles Church, Reading. Mr. and Mrs. Croucher are expected to arrive in Trinidad by s.s. *Ingoma* on 28th September.

* * *

Professor F. Hardy returned from England by s.s. *Cavina* on 24th August. In the absence of Mr. H. A. Ballou, Professor of Zoology and Entomology and Commissioner of Agriculture for the West Indies, who sailed for New York by s.s. *Western World* on 6th September, he will be Acting Principal until the return of Mr. Evans who is expected to arrive in Trinidad on 28th September.

* * *

Dr. E. A. Seagar, Professor of Tropical Sanitation and Hygiene arrived in Trinidad by s.s. *Prins Frederik Hendrik* on 2nd September. Dr. Seagar who left at the end of June has been to Barbados, St. Lucia, St. Kitts, Nevis and British Guiana, with the object of collecting data on malaria and other tropical diseases and on the diet and general conditions of the agricultural population of the places he visited.

* * *

The following recently visited the College: Mr. E. Gomez, Brazilian Consul, Trinidad; Mr. A. de Ipanema Moreira, Envoyé Extraordinaire et Ministre Plénipotentiaire du Brésil; Dr. Paul Bartach, Professor of Zoology at the George Washington and Howard Universities and Curator of the Department of Mollusca at the U.S. National Museum; Professor D. Hofman of the School of Hygiene and Tropical Medicine, Porto Rico; and Messrs. F. M. Root, J. Andrews, F. Fish and O. R. Causey of the School of Hygiene and Public Health, Baltimore, Maryland, U.S.A.

EXAMINATION RESULTS.

1. DIPLOMA STUDENTS.

(i) *4th year.*—The following have passed their 4th year examination :—

L. S. Birkett.
J. A. McDonald.
A. C. G. Palmer.

(ii) *3rd year.*—The following have passed their 3rd year examination, and will be awarded the College Diploma :

H. L. Grogan.
R. S. Hanomansingh.
A. F. W. Sheffield.

(iii) *2nd year.*—The following have passed their 2nd year examination and are eligible to proceed to their 3rd year course :—

E. S. A. Chin.
C. A. S. Hynam.
A. F. Nichols.
C. K. Robinson.
J. F. Williams.

(iv) *1st year.*—The following have passed their 1st year examination and are eligible to proceed to their 2nd year course :—

G. Briggs.
J. de la Bastide.
J. L. Goellnicht.
G. R. Gregory.

2. POST-GRADUATE STUDENTS.

The results of these examinations are not yet available.

COLONIAL DEVELOPMENT.

Appointment of Committee.

THE complete composition of the committee to inquire into colonial development has now been officially announced. The names are :— Sir Basil Blackett (*Chairman*), Mr. Ernest Bevin, Sir John Eaglesome, Mr. R. H. Jackson, Sir Felix Pole, and Mr. Alan Rae Smith. Mr. E. B. Boyd and Mr. C. G. Eastwood, of the Colonial Office, have been appointed, respectively, Secretary and Assistant Secretary to this Committee. The Committee's terms of reference are :— In accordance with Section I of the Colonial Development Act, 1929, to consider and report on, in the manner to be prescribed in the regulations to be made by the Secretary of State under Section I (9) of the Act, applications for assistance from the Colonial Development Fund, in furtherance of schemes likely to aid and develop agriculture and industry in the Colonies, Protectorates, and Mandated Territories, and thereby promote commerce with, or industry in, the United Kingdom by any of the means specified in Section I (I) of the Act.

TREND OF THE MARKETS.

[*The notes below are based principally upon running charts of the prices of the basic grades and upon general statistical information gleaned from contemporary publications and cablegrams and are intended to be a record of movements. An attempt is made, where possible, to indicate the market outlook at the time of going to press, but no responsibility for the accuracy and subsequent truth of such observations is assumed. Unless otherwise stated the prices quoted are spot, London.*]

SUGAR.—Prices on the Home Markets have ranged as follows (*c.i.f.* per cwt.):

	Foreign.		*Preferential.*	
	s.	*d.*	*s.*	*d.*
16th August ..	8	9	12	6
23rd August ..	8	6	12	3
4th September ..	8	10½	12	6
14th September ..	9	4½	13	0

Quietness has prevailed in all markets during the first three weeks of August and there was very little of an encouraging nature to impart life into the market. Buyers in the large consuming centres appear to have sufficient stock to cover their needs for the moment, as with the existing statistical position of the article no anxiety is being felt with regard to supplies for the remainder of the year. The feature of outstanding interest was the signing of the Decree by the Cuban President creating a single selling agency in Cuba for the disposal of the balance of the present crop sugars remaining unsold on the 31st August and of the entire 1930 production. *Bona fide* sales of present crop Cuban Sugars for shipment before 31st December, 1929, will be permitted up to the 31st August but no sales of new crop Sugars will be recognised.

* * *

COTTON.—The following are the official spot prices in pence per lb. of the Liverpool Cotton Association:

	American Mid.	*Egyptian F. G. F. Sakel.*	*Sea Island.*		
			Good.	*Extra fine.*	*Prices paid this Week.*
	$ c.	$ c.	$ c.	$ c.	$ c. $ c.
19th July	10.54	17.00	25.50	38.00	25.50-30.00
26th July	10.58	17.05	25.50	38.00	25.00-27.50
2nd Aug.	10.65	17.10	25.50	38.00	26.00-27.50
9th Aug.	10.16	16.50	25.50	38.00	26.00- -
16th Aug.	10.10	16.50	25.50	38.00	—
14th Sept. .... (local)	10.36	—	25.50	38.00	—

At the beginning of August prior to the publication of the first official Bureau report, the market for American was quiet. When this was issued on the 8th August it indicated that the crop would be approximately 15½ million bales as against 14½ million bales for 1928. The markets generally construed the report as being bearish and an immediate decline took place.

COCOA.—Stocks continue very heavy, but as they are in strong hands, the market remains steady. The mid-crop of Accra Cocoa has not come up to expectations, and the Bahia crop, which should now be plentiful, is still uncertain. It would therefore appear that values, which have been more or less stationary for the past few months, shall continue steady. Much will depend on the main Accra crop which, for the past six seasons, shows that 10 per cent. of the total annual crop comes into market in September and 20 per cent. in October. This season there is some indication that the September percentage may be higher and the October figure lower than the average. The heavy months of November and December will depend on whether the heavy rains experienced in July continued into August —(*By courtesy of the Cocoa Planters' Association, Trinidad.*)

* * *

COFFEE.—The latest quotations per cwt. are as follows: Jamaica (Mount), 220*s.*, Costa Rica, 150*s.*, Kenya good mid, 120*s.*, Brazil, 100*s.* The world's visible supply has been put at 6,536,000 cwt. as against 6,324,000 cwt. a year ago. Imports to date are smaller than last season by 7½ per cent. but consumption has only fallen 1 per cent. Uganda is continuing to increase its cultivation of Robusta Coffee and Tanganyika has shown a net increase on the year of £276,000 in coffee sales.—(*Times Trade and Engineering Supplement*, 24th August.)

* * *

TEA.—The latest average prices per lb. are: Ceylon, 17.55*d.*; India, 13.68*d.* are mediocre, but Java, 10.68*d.* and Sumatra, 12.70*d.* indicate the severe pressure on the sale of cheap produce from the Dutch East Indies. This season's sales to date average 14.65*d.* against 16.81*d.* last season. Imports, in millions of pounds 1st January to 31st July have been 1929, 256; 1928, 228; 1927, 230. The removal of Empire preferences has increased supply from non-Empire sources by about 3,500,000 lb. in the course of the last two months. Stocks are returned at 182,862,425 lb. against 154,456,559 lb. a year ago. There is an increase of 9,000,000 lb. in Dutch East Indian.—(*Times Trade and Engineering Supplement*, 24th August.)

* * *

RUBBER.—Quotations for Plantation Sheet have ranged as follows: 17th August, 10¼*d.*; 23rd August, 10 3/16*d.*; 6th September, 10 1/16*d.*; 14th September, 10¼*d.* The market during the first three weeks of August was somewhat inactive and only small fluctuations were recorded. Market sentiment was partly affected by the heavy total of the July shipments from Malaya although the actual effect of these distinctly heavy shipments has been less than might have been expected.

* * *

COPRA—West Indian *f.m.s.* is lower on the fortnight at £22 17*s.* 6*d.* net spot London.—(*West India Committee Circular*, 22nd August.)